The Glass Industry

REG. U. S. PAT. OFF.

Vol. 6 APRIL, 1925 No. 4

The Use of Alumina in Glass

A Discussion of Its Effect on the Properties of Glass

By D. J. McSwiney*

Alumina has always been present in glasses to some extent, although its presence was usually unsuspected or was disregarded. Practically all glass sands and limestones contain some alumina, the amount varying from a trace to more than ten per cent. The attack of the glass on tank blocks, pots, boots, etc., always adds some alumina to the glass, the amount, in the case of continuous tanks, varying from .25 per cent to 1.25 per cent, depending on the type of tank, the temperature carried, the rate of movement of the glass in contact with the walls and throat, the batch composition, etc.

THE action of alumina varies in different batches and under varying working conditions. The action of alumina in flat glass is still subject to dispute among glass chemists.

The results obtained in investigations of the action of alumina compounds on glass vary somewhat with different observers, probably because the action of alumina itself varies in different batches and under varying working conditions, but, while the addition of alumina in window and rolled glasses is still subject to dispute, it is generally agreed that its addition, in some form, is an advantage to the manufacture of bottle glass. Because of this the use of alumina for this purpose has greatly increased within the past few years. There is, however, still considerable question as to how large an addition of alumina is advisable and in what form it may be introduced most effectively and at lowest cost.

Effect of Alumina

Alumina is peculiar in that, while it ordinarily acts like soda and lime in combining with silica, it can also under certain conditions act like silica in combining with lime to form compounds known as calcium aluminates. It is in this form that most of the alumina is present in portland cement. The effect of the alumina on the properties of glass depends not only on the amount present, but also largely on the amount combined with silica and that combined with lime. It is probable that in low lime glasses nearly all the alumina present is in combination with silica, while in high lime glasses a considerable portion of it is in combination with lime. It is partly because of this property of lime of combining with alumina that high lime glasses exert a more corrosive action on refractories high in alumina than on those low in alumina, so that for batches high in lime the most refractory clays are those low in alumina.

Alumina should not be considered a substitute for lime as is often done for it is much more expensive than lime, and the properties it lends to glass and which make its addition of value depend largely on the amount of lime present.

Variation in opinion as to the effect of alumina on the properties of glass in those cases where the result is not very pronounced is often due to a lack of consideration of the effect on the proportions of the other glass constituents resulting from the addition of the alumina. That is, if the alumina be added to the batch without changing the proportion of the other batch constituents, it results in a much greater decrease in the silica content of the glass than of the soda or lime content and the effect will be somewhat different than if the alumina is substituted for lime without any change in the ratio of soda to silica.

Advantages of Alumina

The advantages claimed for the use of alumina are: That it gives a softer glass; a more brilliant glass; a glass which is more resistant to the attack of water, acids and alkalies; that it decreases block and pot attack; that it allows the use of more lime in the glass; that it decreases scum and devitrification; and that it improves the working qualities of the glass.

By a softer glass, a glassmaker may mean one which has a lower melting point, or rather which has a lower viscosity at or near melting temperatures, or a batch which melts to a glass and planes more rapidly or at a lower temperature; the

* Consulting Chemist

two factors are not entirely interdependent. The addition of alumina increases the viscosity at melting temperatures in almost every case, the degree of increase varying in different batches, being apparently greater in high lime than in low lime batches; in some cases the increase in viscosity resulting from the addition of alumina is very pronounced. The effect of the alumina on the rate of melting depends partly on the form in which the alumina is added. In general, in a glass low in lime, if the batch is not otherwise changed, the effect of the addition of alumina is to decrease slightly the rate of melting of the glass. The increase in hardness of a low lime glass, i.e., the decrease in its melting speed, is not pronounced until the alumina content exceeds about three per cent. If the addition of alumina in such a glass is made at the expense of the lime only, the glass is probably still hardened slightly but not enough to be noticeable; if the content of soda alone suffers through the addition of alumina the hardening is pronounced; while if the silica alone is decreased the glass may be softened somewhat by the addition of alumina. In a glass high in lime, the effect of the addition of alumina is to lower the melting point and to decrease the melting time, unless the addition of the alumina is made largely at the expense of the soda; if however, the increase in the viscosity at the melting temperature is considerable, a shorter melting time may be offset by a longer refining period being necessary. It is because of this decrease in the melting temperature that the addition of alumina to the glass in some cases allows an increase in the amount of lime used without an increase in melting temperature being necessary. This lowering of the melting point in the case of high lime glasses is probably partially brought about by the alumina in such a glass being largely combined with lime in the form of calcium aluminates which melt at or near temperatures at which soda lime glasses are melted. Many old bottle glasses contained as much as 20 per cent to 25 per cent lime and less than 6 per cent soda; the ability to melt such glasses depended largely on the fact that these glasses contained 5 per cent to 10 per cent alumina. In order to fuse such a high lime content without the formation of much scum and as these glasses were often so viscous that refining them would be difficult, it was usually necessary to frit the batch materials together before melting to partially combine them and to remove the combined gases.

The addition of small amounts of alumina often greatly increases the brilliance of the glass. The brilliancy caused by the use of alumina appears to be dimmed by exposure to the atmosphere more rapidly than that produced by other means.

The effect of the addition of alumina on the resistance of the glass to water, acids and alkalies varies considerably in different glasses. In low lime glasses the addition of alumina generally causes an increase in resistance toward these materials, although the increased resistance is probably not much more than would be obtained through a corresponding increase in the lime. On the other hand, in high lime batches the resistance towards these materials, especially toward acids, is usually decreased by the addition of alumina.

Diminished Corrosive Action

It is probable that the addition of alumina causes some decrease in the rate of block attack, partly because the presence of the alumina in the glass will decrease slightly the rate at which more alumina will dissolve from the block, but more because the addition of alumina increases the viscosity of the glass and thus decreases to some extent the rate of movement of the glass in contact with the block, and its depth of penetration into the block—both of which are important factors in the rate of block attack. No commercial glass is ever nearly saturated with alumina; I have examined samples of glass taken from near the block in quiet parts of the tank, which although they were perfectly vitrified and transparent, contained about twenty per cent of alumina—nearly all of which was derived from the block.

The claim usually stressed about the value of alumina to glass is that it greatly decreases the tendency of the glass to devitrify, and in this regard, it is probably the most active of all the glass forming elements. This property is undoubtedly of great importance for tube glass which is to be worked repeatedly in the lamp for the manufacture of chemical apparatus, etc., and for this and similar purposes a reasonable amount of alumina is invaluable. For window or bottle glass this property of alumina is of less importance as practically all glass of this class made in this country shows little tendency to devitrify except under extraordinary working conditions; most of the crystalline or scummy material found in these glasses being the result of non-vitrification rather than of devitrification. Certain alumina compounds have a tendency to form scum when used in considerable amounts, from being too slowly or too difficultly soluble in the glass. If a batch shows a tendency to scum due to high lime content the addition of alumina decreases this tendency; in this respect, however, it is not nearly as effective as the addition of a small amount of salt cake.

Effect on Workability

A most important feature of alumina addition is its effect on the working properties of the glass, especially as regards some hand worked and machine made bottle glass. Glass containing alumina is more viscous than that of similar composition without alumina, that is, the alumina glass flows less freely. But at the same time the alumina glass has a wider temperature range over which it can be worked, the minimum working temperature being lower than that of straight lime glass. This is especially true of those glasses which are naturally hard and quick setting because of the presence of a considerable amount of lime; the addition of alumina to such a glass increases its working range considerably, that is, the glass can be worked hotter and colder without becoming too fluid or too stiff.

The addition of alumina has little effect either way on the resistance of the glass to sudden temperature changes. Because it decreases the effect of temperature changes on viscosity, it improves the annealing of the glass by lowering the temperature and the rate at which the glass attains such rigidity that it can no longer adjust itself to the strains set up in cooling. For the same reason in a high lime glass it decreases breakage at the machine due to chilling.

The presence of alumina is the main cause of the forma-

tion of cords in glass. This usually results from the introduction of alumina through the attack of the glass on boots, rings, plugs, or any other refractory object with which the glass comes in contact shortly before it is gathered. The alumina added to the glass by attack on the blocks in the melting end of the tank seldom causes cords unless the attack on the block is very severe at some one point. Cords may result from alumina compounds in the batch if these are too coarsely powdered or of such a nature that they flux into the glass only towards the end of the melting process. Glasses with widely varying alumina contents do not mix readily except under vigorous agitation; for this reason it is advisable that high alumina cullet is not mixed with a low alumina batch, and that on introducing alumina into a batch for the first time that the change in the batch be made in several steps.

IS alumina a desirable constituent of glass? Modern research has completely reversed some existing ideas as to its effects. It has proven that alumina is a valuable material in the hands of the skilled batch mixer. However, it should be used with certain precautions.

As is the case with any other material introduced into a glass batch to modify the properties of the glass, it must not be expected that the introduction of a very small amount of alumina will produce a profound change in the nature of the solid glass; the degree of modification of the properties of the glass depends largely on the amount added. The case here is not the same as with metals and alloys; the character of the crystallization of metals and alloys, on which many of their properties largely depend, may be greatly changed by the addition of very small amounts of some substances.

Sources of Alumina

Alumina can be added to the glass batch in the following forms: As alumina (aluminum oxide), aluminum hydrate, aluminum sulphate, clay, lepidolite, and feldspar. Alumina from all sources acts the same once it is fluxed into the glass.

Alumina and aluminum hydrate (hydrate of alumina) can be readily obtained free from iron and of constant composition. Hydrate of alumina contains about sixty-five per cent alumina; it decomposes at about 300° F. giving water and alumina. Both materials can be obtained in a finely divided condition, but when moist they are apt to form lumps which may pass through the tank incompletely dissolved in the form of small stones, especially as the rate of solution of alumina in some glasses is quite slow, so that under a heavy pull or a low temperature part of the alumina may not have sufficient time to flux into the glass when used in this form in any considerable amount. As a large part of the alumina in this form may flux into the glass only towards the end of the melting operation, any particles above a certain size are apt to form small cords. Of the two materials, the hydrate is the better as its decomposition tends to reduce the size of the particles and thus increase its rate of solution. Bauxite, the mineral from which the hydrate is prepared, can also be used in green or amber, but usually contains too much iron to allow its use in flint.

Aluminum sulphate contains about sixteen per cent of alumina, the remainder consisting of combined sulphuric oxide and water. The last two materials are completely driven off below 1,500° F. The alumina formed from the aluminum sulphate at this temperature is more finely divided than the commercial alumina and thus fluxes in more readily. The price of aluminum sulphate is only one-third to one-half that of alumina or aluminum hydrate, but in proportion to the alumina content it is much more expensive than these materials. Some of the cheapest grades of aluminum sulphate contain considerable iron.

Many glass manufacturers will not consider the addition of clay in any form to the batch, as they believe it to be too refractory. However, molten glass will dissolve almost anything if it is sufficiently finely divided, and this is the case with clay, considerable amounts of which may be fluxed into a glass if care is taken to keep it finely divided and thoroughly mixed with the other batch ingredients. Clay is the cheapest source of alumina. Clays from different sources vary widely in composition, many of them being so high in iron that they can be used in any considerable amount only for green or amber. The alumina in clays fluxes into glass more readily than that in commercial alumina or aluminum hydrate of the same degree of fineness. Clays are very apt to absorb moisture and lump up; if added in this condition it dissolves with difficulty and is likely to form stones or scum.

Lepidolite is a mineral composed of silica, alumina, potash and lithia, usually with small amounts of fluorine and manganese. It is usually fairly free from iron except that which may have been added in grinding, and contains from twenty to twenty-seven per cent alumina. Lepidolite fluxes readily into the glass, its alumina being in a form in which it is readily assimilated. It contains from ten to eighteen per cent potash and lithia, both of which act as fluxes. The only advantage which lepidolite has over feldspar as a source of alumina for transparent glass is a higher alumina content, but this is not nearly in proportion to the much higher price of lepidolite.

Use of Feldspar

Ordinary feldspar is a compound of silica with alumina and potash. The commercial grades always contain some free silica, so that their composition varies. They usually contain 16 to 20 per cent alumina and 9 to 15 per cent potash. Feldspars from some sources, especially those from North Carolina, often contain part of the potash replaced by soda. There is no objection to the use of soda feldspar in glass, except possibly that it is sometimes accompanied by lime feldspar which does not flux in quite as quickly as the other forms. As feldspars and lepidolite melt at or below the melting temperatures of glass, all that is needed for the assimilation of their alumina contents is a simple mixing of the melted material with the molten glass, while in the case of the other alumina materials a comparatively slow com-

bination and solution is necessary. Because of this, scum never forms from an addition of feldspar and as feldspar is one of the cheapest sources of alumina, it is probably the best material to use if considerable alumina is to be added to the glass. Practically none of the weight of a dry feldspar is lost in melting, while the loss in weight of lepidolite is only from 2 to 4 per cent. While the chief role of feldspars in other ceramic products is that of a flux, in a glass batch the feldspar addition cannot be considered any more a flux than is the fine cullet used; in fact the melting or softening point of the fine cullet is much lower than that of the feldspar particles. Feldspars cannot be considered as sources of alkali any more than cullet is considered such a source; the introduction of potash into the glass through the use of a large amount of feldspar cannot be considered an excuse for cutting the soda content of the batch, inasmuch as the addition of feldspar usually decreases the total alkali content of the glass instead of increasing it. Any softening of the glass resulting from the addition of feldspar to the glass is usually due to the alumina content of the spar and not to its potash content.

Many igneous rocks containing alumina can be used instead of feldspars. However, they do not flux into the glass as readily as feldspars and most of them contain too much iron to allow them to be used for anything but dark green glass. They should be ground more finely than is necessary for feldspars and as they are usually tougher than feldspars, the added cost of grinding them is such that in proportion to their alumina contents they may actually cost more than feldspars. Moreover, they are not at present a commercial product in this country and are not obtainable unless ground to order, while feldspars being used extensively are readily obtainable.

As good a grade of spar is not necessary for glass as is necessary for other ceramic products; the alumina and alkali contents of a feldspar for glass may vary considerably but in general the price should vary also with the alumina content.

A good grade of feldspar for glass should contain at least 16 per cent alumina, 12 per cent potash (part of which may be replaced by soda), less than .75 per cent lime and magnesia, and as little iron as possible. The amount of iron allowable depends on the amount of feldspar to be used in the batch, but should never exceed .20 per cent. Most good grades of feldspar contain less than .08 per cent iron oxide. It should contain no particles coarser than 20 mesh, and should preferably be all from 60 to 100 mesh. The loss on ignition should not exceed .50 per cent. The color should preferably be pure white; many spars have colors running from a light cream through pink, buff, red, brown and sometimes black. If the color is due to the presence of manganese as is often the case, it is not objectionable; but a colored spar should be looked on with suspicion until analysis shows the absence of any considerable amount of iron. Feldspars cannot be obtained as uniform as can prepared alumina, or the hydrate or sulphate of alumina, but they are much more uniform than clays.

COST OF ALUMINA PER POUND FROM DIFFERENT SOURCES

Material	Cost per unit weight	Percentage of alumina	Cost per pound of alumina
Clay	$10.00 per ton	30%	1⅓c
Feldspar	$17.00 " "	17%	5c
Alumina	8c per pound	100%	8c
Aluminum Hydrate	7c " "	65%	10.8c
Lepidolite	$70.00 per ton	22%	15c
Aluminum Sulphate	$50.00 " "	16%	15.7c

Use of Sillimanite in Glass Refractories

A recent meeting of the Society of Glass Technology was devoted to the consideration of the use of sillimanite in the glass industry, two papers being presented.

Although much has been done to improve and render more uniform the fireclays now employed, it is of importance to examine other material likely to give better results. A. Cousen and Prof. W. E. S. Turner had made a study of sillimanite and the effect of variation of grain size and of the use of varying types and proportions of bonding agent were dealt with. The most plastic mixtures, and those giving on fireclay the most stable and resistant pots, were obtained by using sillimanite wholly or largely in the fine condition in which the bulk of the material passed through a 100 mesh to the inch sieve. With ball clay as a bonding material good results were found when a proportion of 15 to 30 per cent of bond was employed. The porosity of hand molded specimens was inversely proportional to the amount of bonding agent used and with the addition of 30 per cent of ball clay reached as low as 22 per cent. Actual melting tests with soda-lime, potash lead and fluoride opal batches gave glasses superior in color to, and having a lower iron oxide content than those melted in good fireclay pots. Test slabs both with 15 and 30 per cent of bond withstood a larger breaking load than fireclay slabs after firing at 1,000 to 1,400 deg., but after heating to 100 deg. or 800 deg. the clay slabs gave superior results. The Stourbridge clay mixtures gave promise of producing quite good results when molded into shape under pressure.

F. G. Clark and W. J. Rees, the authors of the second paper presented, stated that tests under commercial conditions showed that molten glass had very little attack on articles made of sillimanite and should have very little effect on sieges made of this material. Bricks of various sizes and thicknesses had also been made of a sillimanite mixture and used for filling up the exit flues of furnaces when they had worn too big. It was found that these bricks stood the heat perfectly. The mixture was also used in a damp state for repairing the bad places between the pillars and springers in an old furnace, with excellent results. The best results had been obtained with sillimanite bonded with from 10 to 25 per cent of ball clay. A covered pot had been made from 25 per cent ball clay mixture soaked for four weeks before use. This pot was 43 inches high and took 15 days to make. Its cost was greater than that of the ordinary fireclay pot, but longer life in the furnace and freedom from pot stones would compensate for this. The material was also recommended for rings floating in the glass and for bottoms of tank furnaces. Its thermal conductivity was higher than that of fireclay. The authors expressed the opinion that sillimanite was the best refractory material yet known for use in the hottest part of any glass furnace, either in contact, or out of contact, with glass.

Raw Materials of the Glass Industry

By J. B. Krak, Technical Editor

All substances entering in any way into the manufacture of glass are to be considered as raw materials of the glass industry. They may be divided into four groups, namely: 1, batch materials, which yield the finished glass; 2, refractories forming the containers in which the batch is transformed into glass; 3, fuels, which furnish the heat required for the transformation; 4, auxiliary substances used in the preparation of the finished glass for market. Upon a thorough understanding of the properties of materials required for glass making depends to a large extent the success of the glass technologist.

Batch Materials

These may be divided into five classes, namely: 1, acidic; 2, basic; 3, coloring; 4, opacifying; 5, decolorizing materials. To the first class belong sand, boric acid and phosphoric acid. The second class comprises chiefly soda ash, salt cake, potash, lime, magnesia, lead oxide, zinc oxide, barium and aluminum compounds. To the third class belong oxides of antimony, cerium, chromium, cobalt, copper, iron, manganese, nickel, uranium, chloride of gold, sulphides of cadmium, copper and sodium, carbon and its compounds and selenium. The fourth class includes cryolite, fluorspar, bone ash, tin oxide; the fifth, manganese, selenium, cobalt nickel, arsenic and sodium nitrate.

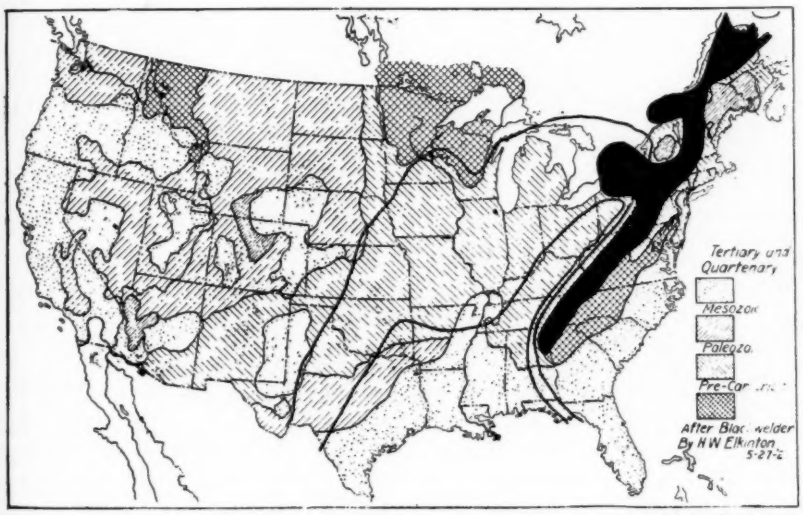
Acidic Materials

Silica, the most important material entering into glass, is of acidic character. It gives definite salts with bases by direct action or by double decomposition to form silicates. Freshly precipitated hydrated silica dissolves rapidly in cold alkaline solutions. Calcined precipitated silica dissolves in boiling alkali. Combination of silica is effected in the dry way by raising the temperature above the fusion point of the silicates formed.

Silica is the commonest of substances. It is estimated that 60 per cent of the earth's crust is silica, occurring in the combined and uncombined form, this estimate being based on numerous rock analyses, calculated to a depth of 10 miles below sea level.[1] In the form of quartz it is a major constituent of all rocks, granite being a mixture of quartz, feldspar and mica.

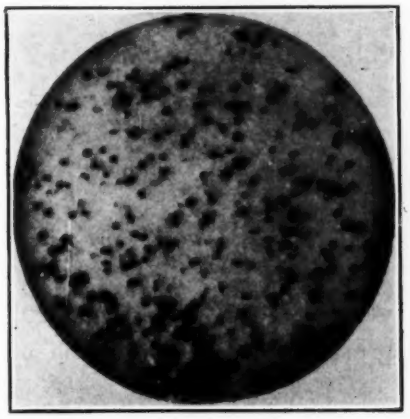
Sand is the product of chemical and mechanical disintegration of rocks under the influence of weathering and abrasion. The predominating mineral is quartz. When sand is of comparatively recent origin the particles are angular and sharply pointed. Older sands have smooth, rounded grains. Transportation of sand by water, its settling in river deltas and along the shore lines of the ocean can be observed today and gives a picture of what happened millions of years ago. The action of waves and undertow, the tides and shore currents have tended to separate the heavier quartz particles from accompanying feldspathic material. The wind has been an important factor in sorting the rock particles washed on the ocean shore. As the sand bars and dunes are now being formed on the coast of New Jersey and Cape Cod so they were laid down on the shores of oceans of bygone geologic ages.

During the Devonian period, referred to by geologists as the Ordovician time, an inland sea arm stretched from the northeast to the southwest of the American continent. It covered western Massachusetts, eastern New York, through Pennsylvania into Maryland, West Virginia and Kentucky. On the shore of this ancient sea were deposited some of the sands quarried at the present time for glass making purposes: those of Pennsylvania, Ohio, Illinois, Missouri, West Virgina and other states. During geologic periods following the



From "Rock Products"

GEOLOGIC MAP OF THE UNITED STATES. THE BLACK AREA IS THE ORISKAN SEA. HEAVY LINES SHOW THE BOUNDARY OF THE ISLAND SEA OF ST. PETER'S TIME.



From "Rock Products"

THE ILMENITE AND RUTILE GRAINS ARE SHARPLY CRYSTALLINE AS COMPARED WITH GRAINS OF QUARTZ.

[1] Clark. The Data of Geochemistry.

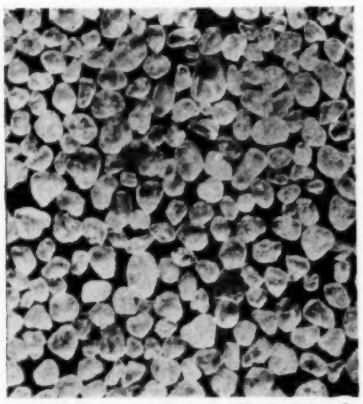
Ordovician the land bearing these sand peposits slowly subsided, and was subsequently covered by thick layers of clay, limestone, coal and sands of later origin. The whole region was subsequently slowly raised hundreds of feet above sea level and subjected to enormous pressure during the formation of what is now known as the Appalachian region. The action of heat, pressure and percolating water tended to consolidate the sands into sandstone, the clay into shale, the calcareous deposits into limestone, the residues of plants into coal. Erosion by water and wind has chiseled valleys and hills in the plateaus, reduced the overlying rocks and has in some cases brought the sandstones to the surface again. Exposure sometimes tends to convert the sandstone again into loose sand. The rate of disintegration depends largely upon the bond cementing the quartz particles together. If it is calcite which combines the quartz, it will loosen more readily that when silica, clay or iron oxide is the bonding substance, because calcite is appreciably soluble in water containing carbon dioxide in solution. Such a sand is often quite friable and can be crushed easily. The well known "brownstone front" houses of the older parts of Baltimore, Philadelphia and New York are built of sandstone having iron oxide as a bond. That they are not proof against weathering can be observed readily in these cities.

The purity of sand, that is its silica content, may run all the way from 80 to 99½ per cent. Since feldspar is the commonest rockforming mineral next to quartz, it is found to some extent in the majority of sands. Other materials are found disseminated throughout sand deposits or segregated into bars and pockets. Sand of the Sahara desert, according to Thoulet[2], contains 89½ per cent quartz, 9½ per cent feldspar, with small quantities of magnetite, chromite, garnet, olivine, amphibole, pyroxine, calcium carbonate, sodium and potassium chloride and clay. Retgers[3] states that the dune sand of Holland contains quartz, garnet, angite, hornblende, tourmaline, epidote, staurolite, rutile, zircon magnetite, ilmenite, orthoclase, calcite and opalite. Other minerals identified were plagioclase, microcline, iolite, titanite, sillimanite, olivine, kyanite, corundum and spinel. Quartz formed from 90-95 per cent of the mixture.

[2] *Bulletin de la Société minière*, 4, 262 (1881).
[3] Rec. trav. chim. des Pays Bas, 11, 169 (1982).

From the glassmaker's standpoint the most important thing to know about a sand is its iron content.[4] The iron in glass sand may occur in two forms. It may be deposited around each grain of quartz. Or it may be an integral part of minerals associated with quartz such as magnetite, Fe_3O_4, hematite, Fe_2O_3 or limonite, $Fe_2(OH)_6Fe_2O_3$.

Ilmenite $(FeTi_2)O_3$ introduces both iron and titanium. Rutile, TiO_2, is of frequent occurrence. When iron is present as limonite mixed with clay it may be largely removed by washing. Cream colored, yellowish and brown sands contain limonite, the depth of color depending on the amount of mineral present. Hematite imparts a reddish brown color to sand. It is not always possible to judge a sand by its color. Almost white sand may contain sufficient ilmenite or magnetite to render the iron content above that of a yellow sand containing limonite.



U. S. Silica Co.

WELL SCREENED SAND

U. S. Silica Co.

INCOMPLETELY SCREENED SAND

From "Glass"

ANGULAR SAND GRAINS

EFFECT OF IRON

The color given to glass by iron depends on its state of oxidation. Ferrous iron gives the glass a bluish green tint. Ferric iron gives a yellowish tint, which is not nearly as noticeable. For this reason it may be advisable to maintain oxidizing conditions during melting. This can be obtained by adding arsenic or sodium nitrate to the batch, or by using red lead instead of litharge. Since bluish green and yellow are complementary colors the presence of both ferrous and ferric iron in small amounts may result in a colorless glass. Manganese, selenium, cobalt and nickel are added to glass batches to mask the color due to iron[5].

PERCENTAGE OF IRON PERMISSIBLE IN SAND

Kind of glass produced	Per Cent Iron Oxide permissible in sand
Bottles (green or brown)	1 —2
Window glass	0.3 —0.5
Plate glass	0.1 —0.25
Mirror glass	0.05—0.15
Flint bottle	0.05—0.15
Lead flint	0.02—0.03
Brown optical glass	0.03—0.04
Optical glass	0.02—0.03

The percentage of iron permissible in sand varies with

[4] For methods of determination see THIS JOURNAL, 2, 13-14, (1921) and 4, 103 (1923).
[5] For a discussion of decolorizers see THIS JOURNAL, 6, 23-26, 53-57, (1925).

the kind of glass that is being produced. Thin ware can stand more color than heavy pieces. Sand used for window glass does not have to be very low in iron since the layer of glass is not thick enough to cause the appearance of color. When light is passed through a number of sheets the color is often very noticeable.

A rough test of the amount of iron present in sand may be made by heating a sample weighing about ten grams in a test tube with hydrochloric acid, 1:1 for a few minutes. The sand is allowed to settle, the liquid is poured off into another tube and a few drops of potassium ferrocyanide or sulphocyanate solution are added. In the former case a blue precipitate appears, in the latter the solution is colored red. The depth of color in each case serves to estimate approximately the amount of iron present in the sand.

Effect of Alumina in Sand

Evidence is accumulating from year to year to indicate that a small amount of alumina in sand is an advantage rather than a detriment. Some manufacturers actually add alumina in some form to the batch to improve the quality of their product. Alumina is reported to increase durability and resistant qualities of glass. When present in small amounts it improves working qualities. It reduces the corrosive action of molten glass on refractories. It makes possible a reduction of the amount of alkali, thus decreasing the cost of production. However, a word of caution with reference to the favorable action of alumina may be in order. The limits to its use in glasses of different composition are variable and the amount that would be beneficial in one type of glass might be detrimental in another. This applies, especially to machine made glass, since slight changes in the viscosity of the metal may have considerable influence.

Other Impurities

Calcium and magnesium oxides and alkalies occur in most glass sands in such small amounts that they have no other effect than decreasing slightly the amount of silica present. As mentioned before nearly all glass sands contain titanium, the amount ranging from a trace to 0.5 per cent TiO_2. Small amounts have no effect on glass but under certain conditions a larger quantity may cause a brownish color.

Effect of Grain Size and Shape

In judging the value of a glass sand the grain size and its shape are of considerable importance. Long before these factors had been recognized it had been noticed that some sands melted down quicker than others and therefore required less fuel to produce a given quantity of glass. Careful study led to the observation that the grains of rapidly melting sand were neither too large nor too small. To insure an even size of sand grains, producers undertake to put the sand through a series of screens, to remove the oversize and undersize grains. The former retard the melting process and may appear in the product as stones. The fine sand dust may cause lumps which fail to mix with the fluxes and retard melting.

Sharp and angular sand grains offer more surface to the fluxes than rounded grains. It is generally believed that angular grains melt quicker. However, very pure sands made up of well rounded grains have been found to give excellent results for all sorts of glass ware. Regularity of size is of greater importance than angularity of the grains.

The following table gives the percentage of the different sizes of grains in some American glass sands:[6]

Size of Grain	No. 1	No. 2	No. 3	No. 4	No. 5
Retained on 10 mesh.....	....	....	0.13	....	....
Between 10 and 14.....	....	0.42	0.76	....	....
14 " 20.....	0.07	0.78	1.63	0.04	....
20 " 28.....	1.59	2.18	6.79	2.16	0.02
28 " 35.....	13.11	7.28	14.76	19.81	0.64
35 " 48.....	61.71	30.75	30.65	38.04	19.70
48 " 65.....	20.25	37.06	23.62	14.19	42.20
65 " 100.....	2.79	19.93	15.61	10.15	28.83
100 " 150.....	0.16	0.85	3.91	6.66	7.08
150 " 200.....	0.03	0.10	1.19	3.68	0.60
Through 200	0.01	0.03	0.75	4.76	0.78

No. 1. Keystone No. 1 Sand, Pennsylvania Glass Sand Co., Mapleton, Pa.
No. 2. Pittsburgh Plate Glass Co., Kennerdale, Pa.
No. 3. American Window Glass Co., Derry, Pa.
No. 4. Wedron White Sand Co., Ottawa, Ill.
No. 5. American Silica Co., Rockwood, Ill.

Preparation of Glass Sands for Market

The complete process of preparation of glass sand includes quarrying or mining, breaking, crushing, grinding, screening, washing, draining, drying, screening to various sizes and storage.

The following is a description of how glass sand is prepared for market by the United States Silica Company, of Chicago:

The sand deposit consists of St. Peter's sandstone which is covered with only a thin layer of sandy loam. This is removed with a steam shovel leaving the sandstone exposed. The sandstone is easily disintegrated by blasting with dynamite followed by washing down of the broken up ledges by a powerful stream of water as in hydraulic mining. The resulting sand suspended in water is then pumped through vacuum pumps to the boot of a drag-belt elevator which delivers it to a revolving screen. The revolving screen removes the hard lumps of unbroken sandstone and any organic matter which happens to be present. The sand after passing through the screen runs to two washbins. Then a large volume of water under pressure introduced through the bottom boils up through the sand and the impurities, consisting mostly of the original binding material in the sandstone consisting of lime, magnesia, alumina and a small portion of ferric oxide is carried off in suspension in water over a dam by a skimming process. The washing is continued until the water runs clear.

In the washbin the sand is again pumped in suspension in water to large drainbins, in which additional water is added and the skimming process is repeated. The drainbins have porous bottoms and gravity drainage removes all except capillary water.

When drainage is completed, doors are opened in the sides and the damp sand runs by gravity on to steam coil dryers which utilize exhaust steam supplemented by live steam from the boiler plant. The pipes in the dryer are so arranged that the sand passes through evenly and is entirely dry by the time it reaches the lower close coil, from which it falls upon a 24-inch conveyor belt with a capacity of two

[6] Fettke—*Glass Sands of Pennsylvania.*

tons per minute. This belt runs in a tunnel to the boot of a bucket elevator which raises the dry sand to the top of the storage building. This elevator charges the sand onto a scalper screen, which removes any dirt or coarse discolored grains from the dry sand. From the scalper screen the sand is conveyed by a series of screw conveyors to 26 vibrating screen separators arranged in units of two. Each of these separators is equipped with 4-foot screening sections which separate the sand into three grades, which have been classified as follows: 1, coarse grains; 2, dust and fine grains, and 3, glass sand.

From the separators the various grades are conveyed on belts to large concrete storage bins, available for loading through gravity loading spouts. Each bin has four loading spouts from whence the sand is chuted into box cars spotted on tracks adjacent to the storage building.

Refractories for the Glass Industry*

By Dr. K. Endell†

The importance of refractory materials to the glass industry is generally acknowledged. Considering the great significance of refractories to glass makers it is astonishing that in the German literature only few articles can be found on this subject. In England and the United States great activity commenced during the war to investigate the properties of refractory material for the glass industry. Specifications and tests have been standardized and have been established as binding.

DR. K. H. ENDELL

This reference to accomplishments abroad will not indicate that the great value of refractories is not also recognized in the leading glass works of Germany. Continually work is in progress to improve the quality of refractories. But there are still a large number of glass works which manufacture their own refractory materials according to secret formulas, partly following ideas which at present have been recognized as being incorrect. These receipts, which always apply to raw materials of a definite composition are passed on from one foreman to another, and since they keep the secrets of their processes carefully, the management is often without much influence in this department, which is of such great importance to the glass works as a whole.

That a proper selection of refractories has been made is indicated by the resistance which they show against corrosion. This insures uninterrupted operation and is an important factor in the cost of glass production. In many cases failure of a glass tank is due to poor quality of the raw materials used in the preparation of refractories. It may also be caused by faulty construction. The life of a glass tank should not be given in terms of days, weeks or months, or in terms of the number of times it has been charged but should be based solely on the quantity and cost of refractories required to produce a ton of salable glass. In the steel industry for instance one counts on the consumption of 30 kilograms, that is 3 per cent of refractory material to every ton of steel produced. In this calculation only the bricks of the furnace proper and the regenerative chambers are included. If all parts of the oven were considered the average cost due to refractories would total about 6 per cent per ton of steel.

What the cost to the glass industry is the author does not know. It is true that the temperatures are not as high as in steel making. But the chemical corrosion of the batch is considerably higher, so that probably about similar figures would be arrived at. If the quantity of refractories per ton of salable glass is not the basis but the cost per ton of finished glass, it will be found in many instances that more expensive materials, while not giving a longer life to a tank may yet enable greater production in a given time. In this way economies are of course effected.

Every step of progress made in the improvement of existing or the development of new refractories can naturally be translated only slowly into actual practice. An experiment easily requires full year. A far reaching knowledge of the methods of preparation and properties of refractory materials and their special application are necessary. Advances can be made easiest in glass works which provide their own needs of refractory materials. The management in these cases is able to reap the benefit of improvements which otherwise go to manufacturers of refractories. The testing of all materials entering into the construction of glass furnaces presupposes an exact knowledge of the requirements of glass works in this respect.

Especially the rapid development of glass making machinery with automatic devices has increased the demands made on refractory materials. These demands have increased also through the general raising of tank temperatures, through the manufacture of glasses which melt at a very high temperature and of those made by using chemicals having strongly corroding properties.

These few remarks may suffice to indicate the great economic importance of refractory materials. An exact control of this department of glass manufacturing will in many cases make possible the development of new glass forming processes and in the final analysis will lead to economies of production.

An example may show the degree of resistance of refractory materials against corrosion. Reference is made to a tank of 100 tons capacity in which glass comparatively rich in silica was made. Filling took place every half hour. The chemical and mechanical corrosion of the tank blocks measuring 600 x 450 x 200 millimeters (23.6" x 17.7" x 7.8")

*Paper read before the German Society of Glass Technology. Translated for THE GLASS INDUSTRY from *Sprechsaal*, Vol. 57, pp. 321-325.

†Professor at the Technical University of Berlin.

in a year was quite large. The tank could have been worked a few months longer but the corrosion of the refractory material and the consequent danger of cords and stones had become so great that the loss of production had become too great. It appeared therefore advisable to stop. If bottles only had been produced the tank could have been operated a few months longer.

The resistance against corrosion without considering the quality of the tank blocks depends on:

1. The chemical composition and the method of preparation of the batch, especially the proportion between batch and cullet.
2. The degree of temperature.
3. The method of firing.
4. The mechanical movement of the molten glass.
5. The way in which the tank is built, size of tank block, large surface, smallest possible joints.
6. The rate of cooling (heat conductivity).

Refractory materials are attacked most violently by the uncombined raw materials of the batch. Intensive experiments by Cobb[1] have shown that in the solid condition at temperatures not above 1,000° C. silica, clay and alkali react to form compounds melting at low temperatures. This refers to both soda ash and salt cake. The chemical corrosion of the tank blocks will be stronger in proportion to the amount of batch. If cullet is used to a great extent, the corrosion is less. This is the reason why at first cullet is melted alone in a new tank so as to protect the blocks from the strongly acting raw materials, especially alkalies.

FIG. 1. MECHANICAL-CHEMICAL CORROSION OF A TANK BLOCK HAVING HAD HEAVY USE DURING ONE YEAR

Since the chemical corrosion of liquid glass in refractory blocks increases with increasing temperature, the latter is of course important. In general it will rarely exceed 1,450° C. If in certain cases the temperature is raised through additional oil firing, special care should be taken to see that no sharp flame bores out the refractory blocks. Aside from the chemical action the mechanical movement of the glass is important. Mechanical corrosion at high temperatures should not be underestimated.

[1] *J. Chem. Soc.* 1910.

From the standpoint of the tank builder, large surface and small joints are desirable. This presupposes large tank blocks, which are difficult to obtain homogeneous throughout. For this reason the advice is often given to manufacture smaller tank blocks since they can be burned more thoroughly.

Water cooling, which is applied to many tanks, helps the resistance of refractory material against corrosion. It is a question of calculation as to what is more important: to use more fuel on account of removal of heat, or to increase the life of a tank. In this method of cooling it is absolutely necessary to see to it that the water cooled tank lies directly against the refractory material. Even a thin layer of air between the two acts as an insulation and causes early corrosion and later destruction of the iron container.

FIG. 2. CHEMICAL CORROSION OF A POT CAUSED BY MELTING OF OPTICAL GLASS

The insulation of a tank by means of insulating material has a deleterious effect on the life of refractories. Fig. 1 shows a chemically and mechanically corroded tank block in which deep crevasses are noticeable. This is the result of normal corrosion produced by intensive production during about one year.

Fig. 2 shows honeycomb-like corrosion of a tank block. The material was obtained from an experimental tank in which a special optical glass was made which was very difficult to melt. In this case only chemical corrosion has taken place.

The highest demands are made on refractories by the new mechanical glass-forming machinery, or automatic measuring and filling devices.

Of great importance to glass manufacturing are the walls and crowns of large tanks which consist of silica bricks, containing about 94 per cent SiO_2. Silica bricks should be burned at such a temperature that they do not expand too much during subsequent use in the furnace. Besides they must be burned until they are hard and compact, so that stones do not drop off in the glass due to action of batch dust on the bricks. A sharp fire can melt down a crown very rapidly.

It is of interest to discuss in how far refractory materials have been investigated and by what method they can be tested efficiently. Table I gives a view of the chemical and physical properties of three different tank blocks which have proven to be satisfactory.

Table I

Comparative investigation of German, Dutch and American tank blocks.

Country:	Germany	Netherlands	United States
Kind of glass made:	Bottles and electric light bulbs	Bottle glass window glass	Electric light bulbs
Clay used:			
(a) raw	Gross almerode pot clay	Clay from Northern France	Grand View Clay (St. Louis)
(b) grog	as above burned at 1,250°	Belgian Seger cone 8 Clay, burned	as above burned
Proportion	1 : 1	?	1 : 1
Chemical Analysis:	Per Cent	Per Cent	Per Cent
Silica	76.42	61.95	64.78
Alumina	17.79	30.88	32.13
Iron Oxide	1.19	1.28	2.36
Titanium Oxide	2.32	1.78	0.19
Lime	0.48	0.54	0.52
Magnesia	0.40	0.35	0.25
Alkalies (calculated as K_2O)	1.16	2.90	...
	99.66	99.68	100.23
Porosity	23%	21%	26%
Melting temp. of Seger-cone	27-1610° C.	31-32-1700° C.	30-31-1680° C.
Softening temp. under load of 1 Kg. per Cm^2—			
Initial softening	1450° C.	1310° C.	1320° C.
Temperature at which cylinder is compressed 4%	1450° C.	1400° C.	1430° C.

Among the methods of testing the following may be noted:

Examination of the texture with a binocular microscope. A certain idea as to the quality of tank blocks can be obtained by observing broken fragments of the refractory,

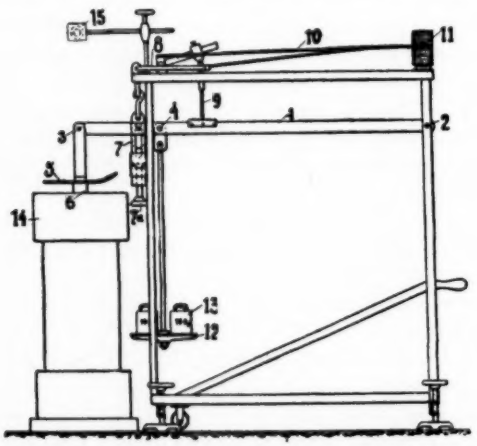


FIG. 3. APPARATUS FOR THE TESTING OF REFRACTORY MATERIALS UNDER LOAD AT HIGH TEMPERATURES (SCALE 1:25)

either with a strong lens or better still with a binocular microscope. It can be seen whether the block has a fine texture, that is, whether really the binding material and grog are intimately combined.

Chemical composition. The great importance which was attributed in the past to chemical analysis is becoming less. The belief in the efficacy of a high percentage of alumina is on the wane, since it has been proven that tank blocks not so high in alumina can be more valuable due to their better physical condition than those high in alumina. It is important, when a chemical analysis is made, to include the estimation of titanium oxide. This oxide may occur in quantities ranging from 1-2 per cent. For the testing of a tank block the determination of the chemical composition is of secondary importance.

Heat resistance is found by means of Seger cones. It is well known that refractories are judged in Germany according to their aluminum content and their melting point as compared with Seger cones. From small parts of the

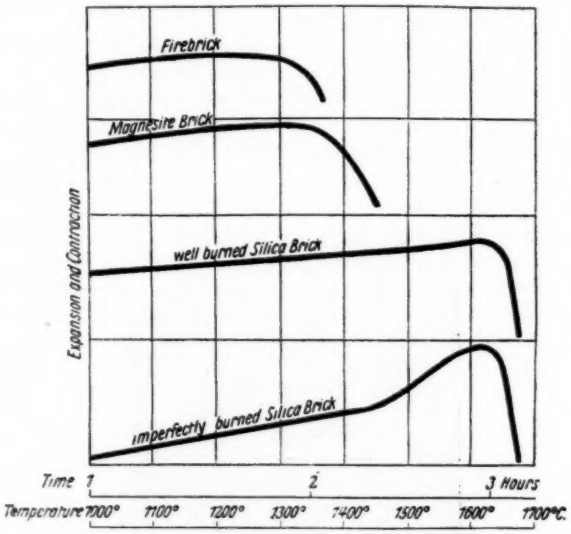


FIG. 4. CHARACTERISTIC SOFTNESS OF CURVES OF FIRE BRICK, MAGNESITE AND SILICA BRICK, AUTOMATICALLY RECORDED BY MEANS OF THE NEW APPARATUS

refractory materials Seger cones are prepared. Their softening points are compared with standard Seger cones in an electric or gas-fired oven. Refractory clays high in alumina which are used in the glass industry have a melting point based in comparison with Seger cones Nos. 32-34 which represents 1,710-1,750° C. Simple as the determination is, yet it is based on false premises for the majority of refractory materials under only a low weight of 1 kilogram per square centimeter soften at much lower temperatures. At the present time, therefore, refractories are tested in all industrial countries with reference to their behavior under load at high temperatures. An apparatus can be used for this purpose which registers as a curve the change in length of a refractory block under load at increasing temperatures. This apparatus consists of an electric oven in which the test block is heated and a lever which can be loaded down with weights and which can exercise a constant pressure on the block in the oven (Fig. 3). Curves obtained by means of this apparatus are shown in Fig. 4. The only exceptions are silica bricks which in general do not soften until they are heated to near their melting temperature above 1,600°. This method of testing allows the making of systematic series of tests which, for instance, can have the purpose to increase the solidity under a load and under otherwise unchanging

conditions. Experiments with this apparatus have shown that by judicious additions to the refractory raw materials the solidity under load can easily be increased.

The mechanical solidity at ordinary temperature is not of such great importance. In general, tank blocks possess a crushing strength of at least 130 kilograms per square centimeter.

Porosity. For the quality of a refractory brick with regard to resistance against corrosion due to the batch and glass, as well as against mechanical attack at high temperatures the porosity plays an important part. It is obvious that a porous block can absorb liquid glass easier than one which is closely grained and which is less solid, mechanically. It should therefore be the object to render a block as compact as possible.

The porosity can be estimated as the capacity to take up water in percentages by weight or as per cent porosity by volume. The former is determined by filling the pores of the sample completely with water and by determining the increase in weight. For the porosity in per cent by volume the determination of the volume of the sample is necessary, which is done by a Seger volume meter or by weighing of a water-saturated sample suspended in water. The amount of capacity to absorb water averages 12 to 15 per cent.

Resistance against rapid changes in temperature. In general well burned refractory blocks show sufficient resistance against rapid changes in temperature. The requirements are not as high as in the iron and steel industry. This property is determined by heating a test sample to a high temperature and letting it cool quickly. The behavior towards this treatment is indicated in numbers, as the loss of body by breaking off of particles or as decrease in the resistance against pressure after cooling. Irregularities in the coefficient of heat expansion caused by changes of condition in the brick, especially of quartz at 575° C. exerts an unfavorable influence on the resistance against rapid changes in temperature, since they have as a result a contraction of the mass at a definite temperature. For glass pot refractories with a high silica content the heat expansion at various temperatures gives a good insight in the sensitivity against temperature variations.

It is obvious that sudden changes in the coefficient of expansion due to allotropic changes play an important part in the behavior of refractory materials under rapid changes in temperature.

Chemical resistance against attack by the batch and the liquid glass. This is one of the most important properties which can be required of refractories. Its testing in the laboratory, however, is most difficult. Especially the influence of time, that is the long action of the glass at high temperatures on refractory bricks and the movement of the liquid glass, is difficult to test. All experiments made in this direction, the making of small depressions in refractory bricks or the making of rings which are filled with batch or with cullet and are exposed to high temperatures are unsatisfactory since the proportion of glass to refractory brick is too small. Too quickly the glass is saturated with the refractory. Besides that the mechanical movement of the attacking glass is not present. Experiments to pulverize refractory materials with glass to press the mixture into Seger cones and to determine the softening temperature are not practicable since in this way the structure and also the outside covering of the refractory material are destroyed.

One of the best methods for testing is that proposed by W. Rosenhain[2] who stirred molten batch with rods made of refractory material in small experimental pots. An excellent test would be to hang up whole tank block in an experimental tank and to determine the corrosion after a certain time. Of course such expensive tests could only be carried out in large glass works. In this connection it may be remarked that with regard to the solution of refractory material by glass it would seem practical if the clay and grog were of the same material or at least of a material which dissolves evenly in glass. In this way the dangerous formation of stones and cords due to the refractory material can be obviated.

The properties and methods given above are also applicable to pots, rings, floaters, etc. Special requirements change in special cases, so that it is impossible to give hard and fast rules for the properties to be demanded with reference to refractory materials used in glass manufacturing.

[2] *Soc. Glass Techn.* III, 1919, 93-116.

Notes on Silvering by the Formaldehyde Process*

By M. A. Cotton

Since the formaldehyde process of glass silvering has been used a great deal by the author, he has been requested to publish the notes on this subject which are distributed to the students of the Optical Institute where his process is applied. Some remarks have been added with reference to the influence of the temperature and the use of crystallized ammoniacal silver nitrate. It should be remarked here that the process as described is due to M. J. Izarn, former professor at Clermont-Ferrand. The use of formaldehyde as a reducing agent for silvering[1] is due to Louis Lumiere who originally used dilute formaldehyde. Later he added alcohol to the bath, which retards the reaction.

Izarn has simplified the procedure by using commercial formaldehyde measured by means of a dropping bottle. The formaldehyde process is economical and requires the preparation of only one bath, the reducing agent being ready for use. It acts very rapidly. The speed with which the deposition of the metal takes place may appear excessive to those who are used to the excellent procedures of Martin and Brashear or who utilize the even slower and more costly method of Threefall who uses Rochelle salts. I have silvered mirrors measuring over 20 centimeters in diameter and believe that larger ones could be silvered

*Revue d'Optique, 3, 57-65. Translated for THE GLASS INDUSTRY.

[1] Most reducing agents used for this purpose are aldehydes or acetones. Invert sugar is used by Martin and Brashear. Formaldehyde is the simplest of the aldehydes and probably the cheapest. A crystalline reducing agent would have the advantage of having an absolutely constant composition.

successfully by the formaldehyde method, described below.

Preparation of the Silver Solution

First it is made certain that the distilled water to be used for the preparation of the bath and for subsequent washing of the objects does not give a precipitate with silver nitrate and that it is neutral to litmus. About fifteen grams of crystallized silver nitrate are weighed. It is not necessary to make an accurate weighing, 10 to 20 grams could be used. It is transferred to a liter flask with a ground glass stopper, partly filled with distilled water. Commercial ammonia is added until the brown precipitate which is formed at first is redissolved. The ammonia can be added rapidly at first but at the end it should be added drop by drop. In order to save time it is advisable to know approximately the volume of the ammonia to be added, which depends on its concentration. Commercial ammonia generally runs 22 degrees Beaume; for one liter of 1½ per cent silver nitrate about 17 cubic centimeters are required. A little less than this quantity is added and at the end ammonia is added drop by drop in just enough quantity to dissolve the precipitate. When it has disappeared the volume is made up to a liter, the temperature is observed and marked on the flask.

The preparation of the ammoniacal silver solution should be done with great care. This applies not only to the use of formaldehyde; it should be observed when using any other reducing agent. Excess of ammonia should be avoided by all means. Its addition can even be stopped when a slight precipitate is still present. If a little too much has been added a small crystal of silver nitrate can be put in the flask. The solution should be shaken until the precipitate formed is dissolved.

Preparation of this solution can be avoided by using ammoniacal silver nitrate which can be bought fully prepared in the market. However, the material must first be tested. There are several kinds of ammoniacal silver nitrate. Text books on chemistry give the formulas $AgNO_3 2NH_3$ and $AgNo_3 3NH_3$. According to tests made by Hirsch in the Physical Research Laboratory the right kind of material has the second formula. Colorless crystals must be selected; those colored grey by reduced silver cannot always be used, even after filtration. A preliminary test should always be made. About 18 grams per liter of distilled water should be used. The bath should have a temperature of at least 15 degrees C.

To test out the bath and to ascertain the required quantity of formaldehyde preliminary tests should be made in a porcelain dish. Commercial formaldehyde is usually 40 per cent but its strength is not constant since it polymerizes slowly by forming a deposit of trioxymethylene. It must therefore be tested out. To this end a graduate and a porcelain dish are cleaned carefully with nitric acid, ammonia and water, and finally with distilled water if tap-water contains too many impurities. In the graduate 15 cubic centimeters of the ammoniacal silver nitrate solution are measured. The predetermined number of drops of formaldehyde are put in a porcelain dish. With the dropping bottles generally in use about 13 drops will be found to suffice. The silver solution is poured on the formaldehyde and the dish is shaken during the process of reduction.

If the proper quantity of formaldehyde has been taken no precipitate is formed upon mixing the liquids, but after a few seconds the liquor becomes violet rose color, showing the typical aspect of a colloidal solution. Then suddenly there appears a layer which becomes successively violet rose, blue, iron grey, and which finally shows a metallic lustre over the whole surface exposed. The reduction, which lasts about a minute, is finished when the liquid contains clearly defined particles.

If not enough formaldehyde is present the liquid becomes grey or yellowish and muddy looking. Silvering does not take place. If there is an excess of formaldehyde the reduction goes too quickly. The silver deposit does not appear metallic or in any case the metallic layer disappears when rubbed with a finger washed with ammonia.

Cleaning the Ware to Be Silvered

This preparation consists in cleaning the surface which must be very clean and must moisten easily. This operation is not difficult if one has new glass, or glass which has just been polished. Mirror makers confine themselves to rubbing the pieces with a wet pad and English rouge before silvering.

It is generally sufficient, especially if an old tarnished silver deposit has to be replaced, to wash the glass first with nitric acid by rubbing with absorbent cotton fastened to the end of a wooden stick. The pad should be washed immediately afterwards and should be used only for acid. Then after washing with tap water the glass should be cleaned with ammonia water by rubbing with absorbent cotton. It is washed again with tap water, then with distilled water, and is left immersed in distilled water to protect it from dust. Glass surfaces which have changed with time or which are covered with a deposit, for instance bichromated gelatin, may be difficult to clean and it is impossible to give a rule which is applicable to all cases.[2] However, even without using rouge, glass can be cleaned by washing it in the following baths: 1, mixture of permanganate of potash and concentrated sulphuric acid; 2, aqua regia; 3, solution of caustic potash. These baths are especially meant for mirrors used in the ultramicroscope for total reflection. But it is rarely that all these operations have to be gone through or that "mordants" have to be used for silvering, such as chloride of tin. Usually nitric acid and ammonia are sufficient.

Arnulf of the Optical Institute uses the following cleaning process whenever the surfaces have no adherent film such as varnish, gelatin, old silvering, etc. The surface is rubbed with chamois soaked with alcohol, and is then covered for five minutes with a mixture of alcohol and water. Every trace of alcohol is removed by washing with plenty of water. While the pieces to be silvered are being washed, the dish which will contain them during the process should be cleaned at the same time. The glass surface should not be touched with the fingers. Use small blocks of wood or plyers.

Silvering by the formaldehyde process is always done by

[2] With certain glasses that are hard to silver, it is helpful to rub the surface rapidly with absorbent cotton during the first seconds of the action of the bath. The moistened cotton undoubtedly aids reduction and leaves on the surface traces which become centers of silvering.

placing the surface to be silvered upward. The volume necessary to effect silvering is measured. The liquid should stand at least a few millimeters above the surface to be silvered. The dish must be such as to permit agitating during the silvering process. If a round disk of thick glass has to be silvered, such as a mirror of a telescope, one can follow the method of Danjon, that is after having cleaned the glass disk it is surrounded by a band of heavy paper of proper dimensions, a few centimeters high, held in place by a large rubber band. This paper forms a wall and less of the bath will be needed than when a dish is used.

The Silvering Process

The required volume of silver solution is measured in a graduated cylinder. In another the corresponding number of drops of formaldehyde is counted out, based on a preliminary test made on 15 cubic centimeters. The silver solution is poured in the formaldehyde, the whole is poured back in the first cylinder, then without loss of time the contents, thus properly mixed, is poured on the glass.

The silvering then takes place regularly and quickly under one condition and that is that the temperature be right. It is believed that the lack of success of those who have tried formaldehyde is due to neglect of this condition. The author has never experienced failure since silvering has only been done at the temperature at which the silvering bath had been prepared. A thermometer dipped in the liquid covering the glass should indicate the temperature.

This rule may be a little too strict. Sometimes good silvering is obtained by surpassing the temperature at which the silver solution had been prepared. Hirsch, using commercial ammoniacal silver nitrate has operated at 30 degrees C. and found the deposit to be heavier. But it should not be expected to obtain good results with formaldehyde at low temperatures (for instance in winter, below 10 degrees C.), by using a bath made up at 20 degrees or even higher in summer. In this case lukewarm distilled water should be used or the piece to be silvered should be warmed and the bottle containing the silver solution should be heated.

The thickness of the silver deposit, obtained by using formaldehyde as described, is estimated at 50 millimicrons. Such a silvering can often be used as it is, although it allows light from a strong source to pass through, giving it a blue color. If an opaque layer is desired, it is advisable to repeat the process and to do it even several times. If this is done it is advisable not to prolong the first ones until the appearance of a yellowish color. That which appears at the last silvering will disappear by polishing. When the silvering process has ended the liquid is transferred to a bottle containing the residues.[3] The glass is washed in the same dish with tap water and then with distilled water. Warm distilled water, when it can be used without danger, is very efficacious. The washing is done more effectively and the water is quickly removed from the surface. The object after being shaken is put on a clean linen cloth or blotting paper so that the water is removed as quickly as possible. Remaining drops may leave visible traces, even if the water is pure. Drying is accelerated by placing near a fire. The ware must be protected from dust. If it is a mirror it should be placed against a support in an almost vertical position with the silvered surface turned downward. This surface, after drying, changes for some time and becomes harder. If it is desired to trace lines with a metal point it must be done immediately after silvering. Silver can replace wax or varnish as a protective cover, when etching with hydrofluoric acid is done.

[3] The silver remaining in the used liquid is precipitated as chloride, and when enough has been collected on the bottom of the container, the silver can be recovered. This is an economy well worth practicing at the present time.

Polishing the Silver Deposit

The Foucault process is always used and it may be helpful to quote it literally.

It becomes necessary to remove the thin layer which colors the silver and which diminishes its brilliancy. Experience has shown that one should begin by rubbing the surface with chamois made into a buffer and filled with cotton. One should avoid putting any polishing powder on the chamois since the rubbing has principally for object to compress the silver deposit, to crush its inherent softness and to give it a hardness permitting it to allow complete polishing.

A singular phenomenon which never fails to be produced seems to demonstrate that under the soft pressure exercised by the chamois, the layer of silver is modified in its construction. The transparency which it shows in a small degree when coming from the bath diminishes considerably by the rubbing. The transmitted blue color becomes deeper as the very small pores transmitting white light become obliterated through the flattening of the salient particles. It is certain that once it is polished the silver layer which has lost rather than gained in thickness transmits less light than before. When the buffer of chamois has produced its effect another one is taken which is impregnated with carefully washed English rouge. It is lightly moved around over the surface, especially over the borders which always show a tendency to remain behind. By and by the silver recovers its whiteness and obtains a polish which reproduces the surface on which it rests. The perfect polish of glass is heightened by the intensity of the metallic lustre, which keeps on increasing until objects are reflected as distinct black images. Then further treatment should be stopped to prevent changes in the texture of the thin silver deposit.

Transparent silvering is done in a single operation. To obtain silver deposits of greater or lesser thickness it is advisable to diminish the speed of the reaction by adding a volume of distilled water equal to one tenth of the volume of the bath employed. In this way one has time to withdraw the object when the silvering process has advanced sufficiently. It is usually not necessary to polish such a surface. A pad of cotton with a little precipitated chalk can be used. If the silver deposit is very light a little oil should be added to the chalk. The oil is later removed with benzine. There is then less chance to scratch the deposit.

Radio Talk on Glass

A series of seven radio talks on Science in Industry has been published by the University of Pittsburgh. These talks were broadcast from the University of Pittsburgh studio of Station KDKA. Of special interest to glass makers are the talks by E. W. Tillotson on glass, by M. C. Booze on clay products and by J. B. Garner on natural gas.

The Glass Industry

ESTABLISHED 1920

The First Trade Journal Devoted Primarily to Glass Technology, Engineering, Raw Materials, and Glass Factory Equipment and Operation

Published Monthly

GLASS INDUSTRY PUBLISHING COMPANY, INC.
50 Church Street, NEW YORK

Telephones { Cortlandt 2465 / Cortlandt 5618 — Cable Address, Glasdustry

J. B. KRAK, Technical Editor

Subscription Price.....$2.00 a Year
Single Copy.....20 Cents

THE GLASS INDUSTRY circulates extensively among American and foreign glass manufacturers, their business executives and technical and factory operating staffs.

ADVERTISING RATES SENT ON REQUEST

Vol. 6 APRIL, 1925 No. 4

CONTENTS

	Page
The Use of Alumina in Glass	69
Use of Sillimanite in Glass Refractories	72
Raw Materials of the Glass Industry	76
Refractories for the Glass Industry	76
Notes on Silvering Glass by the Formaldehyde Process	79
Editorial:	
The Paris Exposition	82
The American Refractories Institute	83
Technical Consultation Service:	
Bloom on Glass Containers	83
New Books:	
Important New Book on Glass	83
Recent Patents	84
The Glass World and What It Is Doing:	
Thinks American Glassware Too Expensive	87
Pressed and Blown Ware Manufacturers' Annual Meeting	87
International Exhibition of Decorative and Industrial Arts	87
Pittsburgh Plate Glass Annual Report	88
Standard Plate Glass Annual Report	88
Hazel-Atlas Annual Report	88
United States Glass Company Annual Report	88
February Building Activities	88
American Ceramic Society Activities	89
Foreign Commerce in Glass Increased in January	89
Trade Activities	89
Personals	90
Recent Deaths	91
Coming Meetings	91
Inquiries Received	91
Stock Quotations	91
Current Prices of Glass-Making Materials	92
Monthly Summary of United States Foreign Commerce in Glass	92

CLASSIFIED BUYERS' GUIDE, PAGE 18
INDEX TO ADVERTISEMENTS, PAGE 20

The Paris Exposition

Some years ago we had occasion to suggest that our country is fortunate to have Herbert Hoover as Secretary of Commerce. His many sided personality, which includes a vision of the picturesque as well as the practical was first revealed when as a mining engineer he had the ability and the interest to translate Agricola's "De Re Metallica" from the Latin. More recently, at a time when his intensely practical campaign for elimination of waste, standardization and simplified practice is being recognized in industrial circles as a factor of prime importance in maintaining both profits and high wages, he creates a precedent by appointing a commission to visit and report upon the Industrial Exposition of Modern Decorative and Industrial Art, which will be held in Paris from April until October. This is probably the first time in history that the United States Government, by an official act, has recognized that art exists and is contributing something of value to the happiness of the nation.

Glassware and ceramics will occupy a prominent place in the exhibition. As a matter of fact, it is recognized that the modern movement in art as applied to manufacturing began some thirty years ago largely in the field of glass and ceramics and has spread to furniture, textiles, wallpaper, art leather and metalware, architecture and landscape gardening. That the exposition will be of outstanding importance to merchants, manufacturers, artists and artisans, as well as to all who are in any way interested in improving living conditions, is assured. It will add thousands to the large number of visitors that throng the capital of France which, whatever else betide, remains the Capital of the World.

The glass industry, old as civilization itself, has always been profoundly influenced by conditions under which mankind has existed throughout the centuries, and has in return responded to man's needs. When civilization reached its highest pinnacle since the fall of ancient Greece, during the Renaissance period, the glass industry contributed the wonderful Venetian glassware and the magnificent stained glass windows of the mediaeval cathedrals of Northern France, Belgium and Holland. The world having entered upon a period of intensive industrialism, the glass industry has responded by creating modern glass making machinery of amazing perfection.

Great as are the contributions of the mechanical engineer to the glass industry it must be recognized that the individual glass blower is threatened with extinction, unless the interest in art glass be kept sufficiently alive to provide a market for the products of the trained glass craftsman. It would be a sad day indeed, that would witness the disappearance of the skilled glass worker. It is therefore with satisfaction that official recognition of the role played by art in the life of the nation is recorded. It is well and desirable that the great mass of glassware shall be produced by machinery. But decadance of art in glass making would be a loss which might prove to be irretrievable. It is gratifying to have it impressed upon the nation that art has its place in human life. The words that "man shall not live by bread alone" apply in this materialistic age to an even greater extent than when they were first uttered.

The American Refractories Institute

Announcement has been made of the proposed organization of a bureau to be named "The American Refractories Institute." Its main purpose will be one of service to users and producers of refractory materials so that the requirements of various industries using refractories may be better understood by those who manufacture them. Of especial interest is the announcement that a research laboratory will be maintained for the purpose of studying the problems with which the industry is confronted.

There cannot be any doubt but that there exists an urgent need for the establishment of an institute of this character. A number of prominent glass manufacturers have from time to time expressed the wish that such an organization be considered. It is felt that the producers of refractories will also give their whole hearted support to this undertaking which will aid in focussing the attention upon the many problems pressing for solution. The glass industry is certainly alive today to the importance of refractory materials as one of the prime factors in the production cost of glass and will watch developments with a great deal of interest.

Technical Consultation Service

QUESTION 70. BLOOM ON GLASS CONTAINERS. Will you please advise us regarding the appearance of "bloom" on glass containers? Our formula which we changed later was as follows:

Sand	500
Hydrated lime	60
Soda Ash 58%	185
Borax	1½
Nitre	½
Arsenic	1
Decolorizer	Varies

This gave us a glass high in luster, easily worked in our feeders, free from glass checks and a pure water white, but also a foggy appearance upon five or six weeks in the warehouse.

Our furnace was carried at 2,200° while this formula was being used. Furnace is 75-ton capacity, using natural gas for fuel, which gives us a good clean fire. We are using feeders only and pulling about 15 tons every 24 hours, specializing in small ware. We have never been troubled with seeds, cords or stiff glass.

We recently changed the batch to the following:

Sand	500
Limestone	102
Soda ash	183
Salt cake	5
Plaster paris	½
Decolorizer	Varies

We thought this would eliminate the fog and also give us a more thoroughly agitated glass, but we found the following: glass very glossy, easily worked, but very dark in color, subject to glass checks and lehr breakage and that the bloom now appears in spider web formation on the inside of the bottles.

In accordance with the new formula we raised the tank temperature to 2350, and 2400, but with no results toward eliminating the fog. Is this condition caused by impure soda ash or lime?

We have changed back to hydrated lime, finding that we can control our color better and that it gives us a clearer glass. Its cost is not much greater than limestone and our color costs have been cut down by its use to nearly repay us.

Do you advise a higher temperature than 2350, and if so, why?

ANSWER: We feel certain that the bloom appearing on your glassware in storage is due to a lack of lime in the glass and that the temperature of the furnace has nothing whatever to do with its occurrence.

Since you do not give us the composition of the finished product, nor that of any of the raw materials it is impossible for us to give you definite figures. Assuming that the materials which you use are high grade we calculate the composition of the glass made according to the first formula given us in your letter, as follows:

Silica	76.5%
Lime	6.9%
Sodium oxide	16.5%

This glass is more than one per cent too low in lime, which, in our opinion, accounts for the bloom.

The change to the second formula would have been a step in the right direction, if the limestone had been pure. Evidently this was not the case since you mention the fact that the glass was dark in color, subject to glass checks and lehr breakage. This indicates that the limestone is low in lime and contains iron and probably organic matter.

We would suggest the continuation of your first formula, but advise you to use 74 lbs. of hydrated lime. This will give you a glass analyzing about as follows:

Silica	75.4%
Lime	8.4%
Sodium oxide	16.2%

In order to make this glass you should run a slightly hotter furnace. We would further suggest that glassware should be kept in a dry, light storage place. Storage in a dark, damp room is conducive to bringing out bloom on glass low in lime. Packing in wet hay is also apt to cause trouble.—J. B. K.

Important New Book on Glass

A TEXTBOOK OF GLASS TECHNOLOGY by F. W. Hodkin and A. Cousen, with a foreword by W. E. S. Turner. XXIII and 523 pages, 251 illustrations. Size 6 x 9¾ inches. Bound in cloth. For sale by THE GLASS INDUSTRY, 50 Church Street, New York. Price $12.00. (See chapter titles and announcement on page 3)

The dearth of text books on glass technology has been felt for a long time by all those interested in glass manufacturing. It has been a serious handicap to glass makers and students alike. Whatever literature was available on the subject was either fragmentary or obsolete. This applies especially to books in English.

When the Society of Glass Technology was organized in England, and the series of splendid investigations began which were published in the society's journal, it became the expectation that a volume on glass technology would some day be written by men closely identified with the work done at Sheffield University. The urgent need for a text book of this character had been expressed at meetings of the society from time to time. It was therefore with great interest that the news was received of the publication of a text book on glass technology by F. W. Hodkin and A. Cousen, names well known to readers of the *Journal of the Society of Glass Technology*.

The difficulties confronting the authors were tremendous and whatever shortcomings this book may have can be attributed largely to the fact that the breadth of the field covered is such as to make it well-nigh impossible to do justice to its every division and to obtain perfect balance in the presentation of the many subjects involved.

It is certain that the authors have done a very creditable piece of work. The problem before them was to write a book which, while understandable to the man with little or no training in underlying sciences, would also be of value to the trained and experienced technologist. It is not surprising to find that this dual object has not always been attained. On the whole, however, the presentation has been one of marked clearness and simplicity and absence of abstruse theory, usually irritating to the man actively engaged in manufacturing.

The physical and chemical properties of glass, raw materials and the effect of various batch ingredients on the physical properties of glass have received a very thorough treatment. The chapter on calculations for glass making will be useful to the glass maker, as will those on fuels, pyrometry, refractories and furnaces.

It was to be expected that the subject of glass forming machinery could only be outlined. The patent literature alone would require a volume for an exposition at all adequate. The same, to a lesser extent, can be said with reference to gas producers.

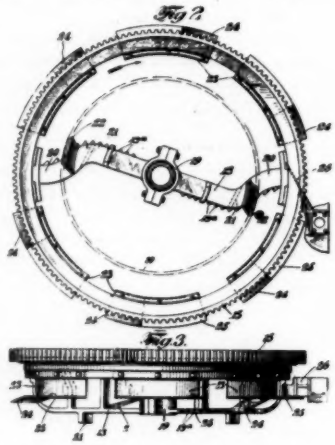
The authors are to be congratulated upon doing a piece of pioneering work that marks a milestone on the road of progress in glass manufacturing. The volume will materially lighten the task of manufacturers, teachers and students of the present day. We venture to predict that it will be referred to as a "standard work" for many years to come.

Recent Patents

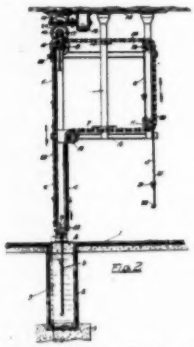
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

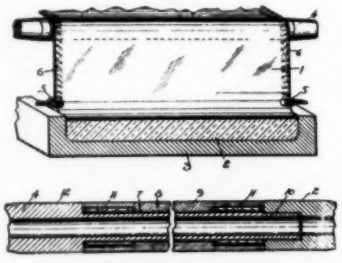
ASH-EJECTING APPARATUS FOR GAS PRODUCERS. 1,528,911. Mar. 10, 1925. William B. Chapman, assignor to Chapman Engineering Co., Mt. Vernon, O. Filed 7/28/21. This invention relates to a gas producer having stationary side walls, a stationary ash pit and stationary hood, the side walls having associated therewith a lip projecting downwardly into the ash pit to provide a water seal for the interior of the producer, and means extending into the water seal for removing ash outwardly from under the side walls and past the lip to the portion of the ash pit exterior thereto.



APPARATUS FOR DIPPING SHEET GLASS. 1,529,239. Mar. 10, 1925. Robert P. Callard, Charleston, W. Va., assignor to the Libbey-Owens Sheet Glass Co. Filed 1/7/22. An apparatus for removing a coating from sheet glass, comprising a tank containing an acid solution, an endless conveyor traveling above but outside of the tank, and a plurality of sheet carriers suspended from the conveyor, the conveyor successively lowering each carrier and sheet into the acid bath to remove the coating and then elevating it therefrom. Each carrier comprises an upright frame structure, a lower grooved member for supporting the lower edge of the sheet, and an adjustable latch for engaging the upper edge of the sheet, all of the carrier parts being non-metallic and no part of the metallic structure entering the solution at any point in the operation.



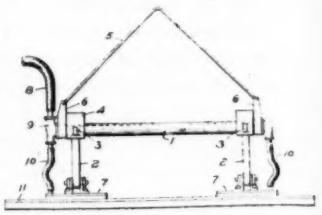
BENDING ROLLER FOR DRAWN SHEET GLASS. 1,529,274. Mar. 10, 1925. Joseph A. Reece, Toledo, O., assignor to Libbey-Owens Sheet Glass Co. Filed 2/4/24. The invention relates to an apparatus for drawing sheet glass consisting of a roller about which the sheet is deflected from one plane into another, the roller comprising end portions for carrying the edge portions of the sheet, and a freely rotatable sleeve journaled on the central portion of the roller, and having a cylindrical sheet-carrying surface of the same diameter as the end portions, in combination with a pair of driving rollers engaging the opposite faces of the edge portions of the sheet.



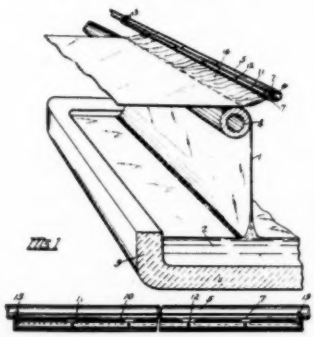
GLASS-CUTTING MACHINE. 1,515,129. Nov. 11, 1924. Alvin L. Mayer, Long Island City, N. Y. Filed Apr. 9, 1923.

This invention relates to machines for cutting glass plates to obtain a plurality of smaller plates, especially to the cutting of photographic plates which have been properly exposed, developed and fixed to obtain plates of the kind, size and shape for use in projecting the photographs.

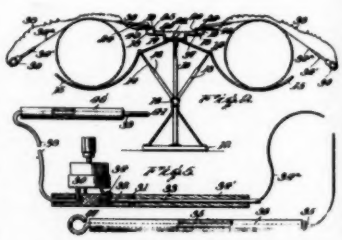
PROCESS AND APPARATUS FOR HANDLING GLASS SHEETS. 1,519,243. Dec. 16, 1924. Gustav Edw. Ericsson, Ford City, Pa., assignor to Pittsburgh Plate Glass Co. Filed 12/5/23. A vacuum lifting and turning device for sheet glass comprising a U-shaped frame lying in a vertical plane and opening laterally with the upper leg of the frame extended out beyond its lower end, suction means pivoted to the end of the lower leg of the frame and adapted to engage the sheet along one edge, lifting means secured to the upper leg of the frame above the suction means, and a counterweight secured to the extended portion of the upper leg.



REHEATING BURNER FOR SHEET GLASS. 1,529,275. Mar 10, 1925. Joseph P. Reece, Toledo, O., assignor to Libbey-Owens Sheet Glass Co. Filed 2/23/24. The invention relates to an improved type of gas burner comprising a gas pipe having a longitudinal series of openings in one side, an adjustable valve plate over the air inlets, and a mixing chamber covering the openings and having a narrow slot in its outer portion opposite the series of openings, the edges of the slot being formed of heat-resisting material and a screen in the chamber.



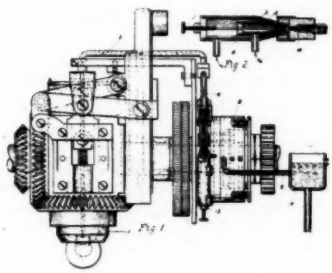
CAPPING-OFF DEVICE. 1,528,135. Mar. 3, 1925. Gus W. Swanson, Morgantown, W. Va. Assignor to the United States Window Glass Co. Filed 10/18/22. Device for capping-off glass cylinders, and for cutting such cylinders into flattening lengths incidental to the manufacture of window glass. Some objects of the invention are to produce simple means whereby an electric heating wire may be utilized for applying the cracking tension to the glass, to provide a device which may be adjusted to cylinders of different diameters, to provide means whereby the heating wire may be snugly drawn around the cylinder to be operated on, and held in position to secure the cracking tension, and to provide a device in which the horse normally employed to support the cylinder during the "capping-off" and "cracking off" operations, may be utilized to support the line wires and contacts complemental to the contacts of the heating wire.



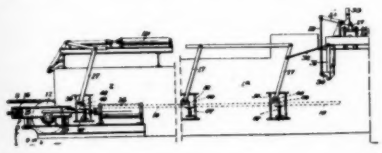
GLASS-BLOWING MECHANISM. 1,527,559. Feb. 24, 1925. August Kadow, Toledo, O. Assignor to the Westlake Machine Co. Filed 7/6/10. A principal object of the invention is to provide mechanism which shall receive the plastic glass, preferably a hot and

plastic blank which has been gathered by other mechanism, and to blow and otherwise manipulate such mass of plastic glass into blown glassware, either partially or completely finished, in a manner in some respects analogous to hand manipulation by the skilled glass-blower. The invention provides for a carrier for a mass of glass, automatic means for swinging said carrier with the glass thereon in a vertical plane and about a horizontal axis through predetermined oscillations to "swing" the glass, and means for automatically bringing said carrier with the glass thereon to rest at a fixed point in a vertical position.

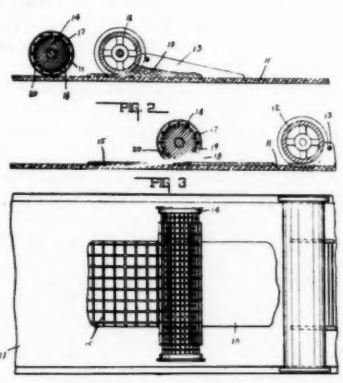
METHOD AND APPARATUS FOR BLOWING GLASS. 1,529,540. Mar. 10, 1925. Orin A. Hanford, Columbus, O., assignor to the Federal Glass Co. Filed 3/7/21. The invention relates to the introduction of air into partially formed blanks of glass during the stages leading to and including the final formation of the articles to be produced. The apparatus comprises an air conducting conduit, a liquid conducting conduit, means for combining such air and such liquid and means for actuating the first named means to intermittently effect the introduction of such moisture impregnated air into the interior of a glass blank.



LEHR. 1,529,177. Mar. 10, 1925. Samuel A. Forter and Adolph H. Meyer. Assignors to H. L. Dixon Co. Filed 6/4/21. The combination with a plate glass annealing lehr having longitudinally reciprocable pulling rods and vertically movable lifting rods, of mechanism for feeding the glass plates onto the rods, said mechanism comprising longitudinally extending pusher rods operatively connected to the pulling rods to reciprocate therewith and having depending pushing devices, together with means for automatically raising the pushing rods in unison with the lifting rods to permit the return movements thereof.

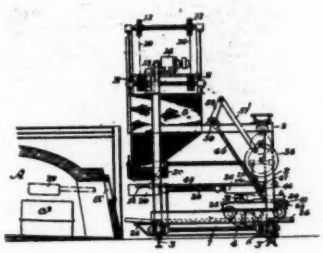


MARKING ROLLER FOR FORMING GLASS WAINSCOTING. 1,528,194. Mar. 3, 1925. Martin L. Burgess, Indianapolis, Ind., assignor to Marietta Mfg. Co. Filed 11/17/23. The invention comprises a roller for marking a decorative and sanitary glass panel, having a plurality of peripheral and longitudinally extending grooves formed therein and spaced apart equidistant, a plurality of annular flange-like ribs adapted to be removably and selectively mounted in the peripheral grooves, and a plurality of straight flange-like ribs adapted to be removably and selectively mounted in the longitudinal grooves for engaging and forming impressions in the soft surface of the semi-molten glass plate.

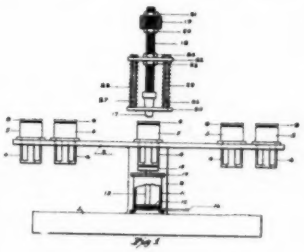


GLASS CARRYING AND LAYING FRAME. 1,525,146. Feb. 3, 1925. William Owen, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 9/11/23. The invention includes in combination in a glass carrying and laying frame, a vertical framework, means for supporting the framework from its upper edge, and hook means along both edges of the frame on one side thereof, the hook means at both edges being movably mounted so that they may be adjusted to fit around the edges of the sheet of glass to be lifted.

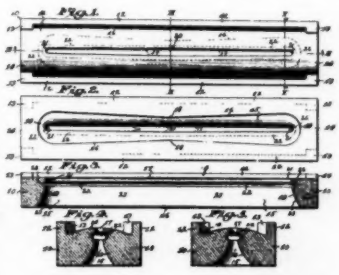
POT-FILLING APPARATUS. 1,528,531. Mar. 3, 1925. James W. Cruikshank, Pittsburgh, Pa. Filed 11/27/23. This invention relates to a pot filling apparatus, comprising a traveling carriage adapted to be moved along in front of a furnace, a batch-supply receptacle carried by the carriage, a ladle support mounted in the carriage for movement towards and from a furnace, a ladle carried by the support and adapted to receive a batch from the receptacle, a batch container supported on wheels whereby it can be moved from a filling station to the carriage, and means carried by the carriage for elevating the container from the ground level into dumping position with respect to the receptacle and automatically dumping its contents into the receptacle.



APPARATUS FOR FORMING GLASS ARTICLES. 1,529,365. Mar. 10, 1925. David L. Middendorf, Columbus, O. assignor to the Federal Glass Co. Filed 10/3/22. An apparatus for producing glassware, a mold, a mold ring, mechanism for shaping the glass in the mold, and anti-friction means carried by the shaping mechanism and contacting with the mold ring during shaping for preventing transmission of torsional movement of the shaping mechanism to the mold ring.



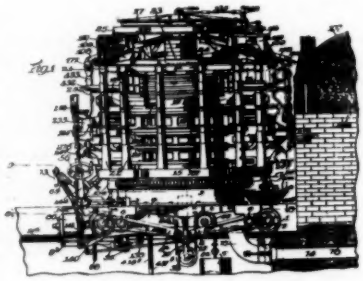
SUPPLYING FLOAT FOR DRAWING SHEETS OF GLASS. 1,529,086. Mar. 10, 1925. Jules J. Quertinmont, Point Marion, Pa. Filed 8/2/24. This invention relates to the floats or "debiteuse" which are used in connection with the "Fourcault" system of drawing continuous sheets of glass. It provides for an elongated supply-float for drawing a continuous sheet of glass having a raised or elevated outer edge on its upper face, said face sloping downwardly from its longitudinal center section towards each of its longitudinal sides and a slot with an elongated upper opening at the highest portion of said upper face and a lower opening, and a continuous narrow groove within and in each side wall of said slot and adjacent to and below the upper opening and extending to within a short distance of the edge of said upper opening.



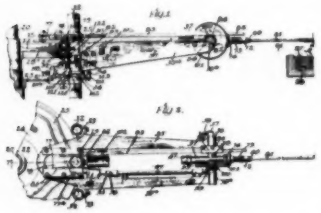
CHANGING BENDING ROLLS IN SHEET-GLASS-DRAWING MACHINES. 1,529,268. Mar. 10, 1925. Joseph M. Neenan, Shreveport, La., assignor to the Libbey-Owens Sheet Glass Co. Filed 2/23/24. An apparatus for changing bending rollers in a machine for drawing a continuous sheet of glass and deflecting the plastic sheet about a bending roller, comprising an auxiliary sheet-supporting roller, a pair of guides, one at either side of the machine, each guide extending from a point above and outside of the bending angle of the sheet to a point below and inside of this angle, a bearing for an end of the auxiliary roller movable along each guide, and means for simultaneously moving the bearings so that

the auxiliary roller is carried from a position within the sheet angle and out of contact with the sheet, to a sheet-supporting position, the sheet being simultaneously lifted from the bending roller.

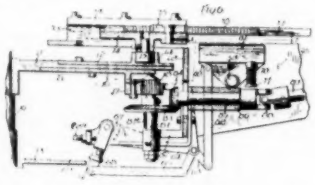
GLASS-WORKING MACHINE. 1,527,556. Feb. 24, 1925. August Kadow, Toledo, O. Assignor to the Westlake Machine Co. Filed 7/6/10. The invention is applicable to the type of machine which rotates continuously on a vertical axis and carries one or more units which successively dip into the vessel containing the metal, especially if such vessel be a glass pot, automatically gather the metal, and deliver it to mechanism which swings out the resulting blank and then brings it to the desired form in a paste mold in a manner heretofore accomplished only by hand. It consists of a traveling gathering device, a constantly traveling holder for the gather normally with the gathering device, means for causing the gathering device to move to and from a mass of molten glass independently of the holder, to gather glass from the mass, and means for causing the gathering device to discharge into the holder during the further travel of the two together.



GLASS-FORMING MACHINE. 1,527,557. Feb. 24, 1925. August Kadow, Toledo, O. Assignor to the Westlake Machine Co. Filed 7/11/10. The invention consists of the combination with a glass pot, of a gathering device, means for causing the gathering device to enter the glass in the glass pot and to be removed therefrom, means for causing the gathering device to be oscillated back and forth, mechanism which causes said gathering device to be revolved while in the glass pot, and means for putting the last-mentioned mechanism out of operation during the period of oscillation.

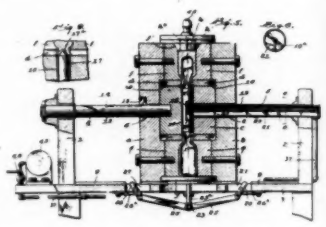


MARVERING MECHANISM FOR GLASS FORMING APPARATUS. 1,527,558. Feb. 24, 1925. August Kadow, Toledo, O. Assignor to Westlake Machine Co. Filed 2/11/10. This invention relates to automatically operated glass forming apparatus, and particularly to mechanisms adapted to perform the operation known as marvering. It consists of a machine for producing glass articles, the combination with a blow-pipe, of marverer, means for producing a marvering action between the gather and the marverer, and means for automatically causing the marverer to approach and recede from the gather during the marvering in a predetermined manner.

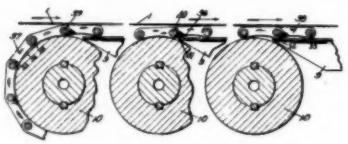


SHEET GLASS CLAMP. 1,525,122. Feb. 3, 1925. Gustav E. Ericsson, Ford City, Pa., assignor to Pittsburgh Plate Glass Co. Filed 6/5/24. The invention relates to clamps for gripping and transporting glass in sheet form. It has for its principal objects, the provision of a compact clamp which occupies a minimum amount of space laterally, so that it may be easily operated between racks which are close together, which provides for clearance in the clamp above the glass, so that in lowering the clamp to gripping position, there is little danger of striking the edge of the glass, and which can be readily operated from below or by the operator above in the crane.

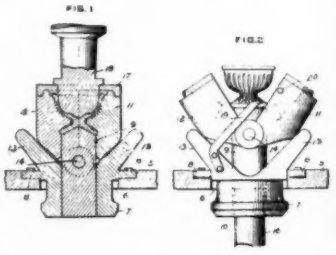
MOLD FOR MAKING BOTTLES. 1,529,519. Mar. 10, 1925. John J. Wanko, Westport, Md. Filed 5/23/21. This invention comprises means for forming each bottle by two successive operations, in a pair of molds, in one of which the mouth and neck of one bottle is formed while the body of another bottle is being finished in the other mold, the apparatus including means for releasing the finished bottle from the latter mold and for transferring the unfinished bottle from the former to the latter mold upon the opening of the mold parts.



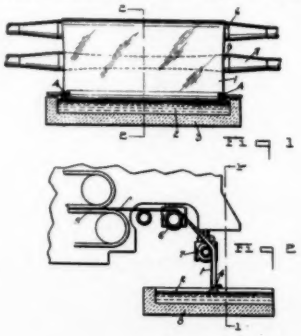
FLATTENING TABLE FOR CONTINUOUS SHEET GLASS. 1,529,243. Mar. 10, 1925. John L. Drake and Lewis D. Blackshere, Charleston, W. Va., assignor to Libbey-Owens Sheet Glass Co. Filed 1/30/24. A drawing and flattening table for sheet-glass, comprising in combination a pair of rotary cylindrical drums, a stationary table positioned between the drums and having a flat upper supporting surface, and a flexible link belt adapted to travel around the drums and over the table, the belt consisting of a plurality of pivotally connected links, each link having a flat upper sheet-supporting surface, and a lower surface of such conformation that the pivot centers of the links will be the same distance from the cylindrical link-supporting surface of the drums, while on the drums, as these centers will be from the flat link-supporting surface of the table, while on the table.



SECTIONAL MOLD. 1,529,622. Mar. 10, 1925. Reuben Haley, Beaver, Pa. Filed 2/14/22. The invention comprises a mold support, a multi-part mold, comprising a mold section forming a wall of the mold cavity, and two mold sections pivotally secured to the first section to turn about a single pivot point and each having a portion of the mold cavity formed therein, the pivot point of the last mentioned sections, being so located in an extension of the longitudinal axis of the mold cavity and the contour of the mold surface being such that the sections swing free of the molded article as they swing outwardly about their pivot points.



SHEET-GLASS- DRAWING APPARATUS. 1,529,278. March 10, 1925. Clifford A. Rowley, Toledo, O., assignor to Libbey-Owens Sheet Glass Co. Filed 2/18/24. The invention relates to the art of drawing sheet glass using an improved form of roller about which the plastic sheet is deflected from one direction of travel to another, the sheet-carrying surface of the roller being concaved inwardly toward the central portion of the roller which is of larger diameter adjacent the ends of the roller than at the central portion thereof.



The Glass World and What It Is Doing

News of the Industry

Thinks American Glassware Too Expensive

To the Editor of The Glass Industry:

We beg to acknowledge receipt of your letter and are much obliged to you for the inquiries you have made as regards quotations on black glass cold cream jars with acid matt finish.

We have received two replies from American glass factories. These firms have also been kind enough to send us a specimen of what they make. This is quite satisfactory as regards the quality and style.

We regret, however, to inform you that we are afraid there is considerable difficulty as regards prices, which appear to us to be very high in comparison with what European concerns are turning glass out at.

It is to be regretted that the American glass industry is not in many respects ahead of same in this country. At the present time American prices compare very unfavorably in many respects with those of the European competitors in spite of the fact that the pound sterling is now practically on a level with the dollar.

It is, of course, a great pity. America has a high mechanical efficiency, and in many respects is leading the day in taste and ideas. The one great trouble is that the whole standard of wages and living is very much higher in America than in other parts of the world. We cannot afford to pay your prices, so that in this respect America forms an industrial world of its own at the present moment.

It seems likely that these conditions of affairs will last a long time. There is no tendency in Europe for prices to rise; on the contrary, the general tendency here is for prices to go gradually back to a pre-war basis.

As long as these conditions of high prospects last there seems little hope of prices dropping in the United States, and until the two worlds meet in this respect there are hardly any prospects of doing any considerable business.

We are at all times anxious to place our orders with American manufacturers as we feel that you are still the land of new ideas, and we like to handle your goods as much as possible. The matter is still receiving our consideration and possibly we shall be able to do something with the works in question.

Yours faithfully,

Young & Hodgson, Ltd.

January 26th, 1925.
York House, 140-142, King's Cross Road, London, W. C. 1.

Pressed and Blownware Manufacturers' Annual Meeting

The National Association of Manufacturers of Pressed and Blown Glassware at its annual meeting held in Pittsburgh, Pa., March 10, re-elected the following officers for the ensuing year: E. J. Barry, president; C. B. Roe, vice-president; J. D. Wilson, treasurer; John Kunzler, secretary, and Charles E. Voitle, assistant secretary.

At a conference held at the same meeting with the Executive Committee of the American Flint Glass Workers' Union the following arrangements were made for the summer vacation:

First—That any workman who desires it shall be entitled to a vacation of two consecutive weeks or less. Workmen desiring more than two weeks may take more time, providing satisfactory arrangements can be made with the manager.

Second—That the vacation period shall be between the dates of June 27 and September 26, with the understanding that not more than one-fourth of the workmen in any plant shall be off at any one time; but when plants are completely closed down for any period of time, then an effort be made to have the shut-down take place June 27.

Third—The date the workmen may take their vacations shall be agreed to locally, but each workman shall be informed one week in advance as to what day his vacation shall begin.

A number of disputes that had arisen in some of the factories since the last conference with the Workers' Union were considered and amicably adjusted.

Exhibition of Decorative and Industrial Arts

For the first time an international exposition is to be held that will be confined to examples of decorative and industrial art conceived in the modern spirit—a very significant event in the history of the arts.

The International Exhibition of Modern Decorative and Industrial Arts at Paris will occupy The Esplanade des Invalides, the Alexandre III Bridge and the gardens of the Cours la Reine, the entire Grand Palais: and the quays of the Seine, from the Concorde to the Alma Bridge. Practically every foreign country will exhibit its artistic products.

In the words of the official printed program, "Works admitted to the Exposition must show new inspiration and real originality. They must be executed and presented by artisans, artists, manufacturers who have created the models, and by editors, whose work belongs to modern decorative and industrial art. Reproductions, imitations, and counterfeits of ancient styles will be strictly prohibited."

The hall and galleries of the Grand Palais are assigned to receive in a sumptuous setting the products of trades and industries "de luxe."

Collective exhibits of French and foreign artists and manufacturers will be shown in separate pavilions, on the Cours la Reine, along the quays, and upon the Esplanade.

Less important groups or individual exhibits will be located in galleries of the Esplanade des Invalides.

The Exposition represents a very important milestone in the long stretch of years from the time when the machine replaced the craftsman as the labor element in producing industrial art—years that were marked for half a century by awful examples of the florid and ornate and in later times by slavish copying of the older forms and methods. Of these later years, M. Clouzot, Conservateur of the Musee Galliera, has said, "We assist at the extraordinary spectacle of a society which is heated by steam and lighted by electricity, which travels by automobile and converses by telephone, living in a decoration of the period when Mme. de Maintenon was carried in her chair and when Mme. de Sevigne wrote letters which required fifteen days to reach Brittany."

The exhibition, of which fine glassware will be a feature, is divided into the following groups:

Group 1—Architecture. Architecture, artistic and industrial stone-working, wood-working, metal-working, ceramic ware, glassware.

Group 2—Furniture. Complete suites, wood and leather furniture, fancy articles and articles in morocco leather, artistic and household metal goods, ceramic ware, cut and blown glass, textile industry, paper industry, book industry, games and toys, sporting goods and apparatus, scientific instruments, musical instruments, means of conveyance.

Group 3—Wearing Apparel. Clothing, fashion, millinery, gloves and minor articles, flowers, jewelry.

Group 4—Theatrical, Street and Garden Architecture and Decoration. Scenery and stage properties, objects for the adornment of streets and boulevards, landscape gardening.

The personnel of the Commission appointed by the Secretary of Commerce to visit and report upon the exhibition includes Charles R. Richards, chairman, Henry Creange, Frank G. Holmes and Edward L. Bernays, associate.

Will Discuss Refractories Institute

A meeting is to be held in Pittsburgh on April 14, to discuss plans for the incorporation of the American Refactories Institute. Representatives of industrial firms that use refactories are invited to attend this meeting in order to become acquainted with the plans that have been made. Particulars regarding the meeting can be obtained by addressing Macdonald C. Booze, Temporary Secretary, Mellon Institute of Industrial Research, Pittsburgh, Pa.

Pittsburgh Plate Glass Annual Report

The net earnings of the Pittsburgh Plate Glass Company for the year 1924 were $13,154,273.83, after deductions for depreciation and obsolescence amounting to $3,154,879.40, and for estimated Federal taxes on income the sum of $1,825,000. Federal income taxes paid in 1924 on 1923 earnings amounted to $2,747,650.22 which was $2,349.78 less than the sum reserved out of 1923 earnings for that purpose. The difference has been added to surplus account. Cash dividends paid in 1924 amounted to $8,768,040. Surplus account at January 1, 1925 was $28,911,034.82, compared with $20,152,573.21 at January 1, 1924.

Expenditures aggregating $7,652,720.09 were made during the year, for extensions and improvements, the more important of which were the following:

Completion of the first unit of the Creighton plant for the production of polished plate glass by a continuous process; new electrical power equipment of the Crystal City, Mo., plate glass plant; new dry color manufacturing plant and new power plant at Milwaukee; doubling of capacity of Newark linseed oil plant; new stone crusher and equipment at Kennerdell sand plant; rebuilding two steamers for the Allegheny River sand fleet; the purchase of about 4,000 acres of coal land fronting on the Allegheny River at Johnetta, Pa.; modern equipment for Columbia Chemical Plant; new office building at Baltimore brush plant; new office building and hospital at Crystal City; new office building at Fultonham; and warehouse building in Philadelphia.

Investment account, $41,271,128.30 represents a net increase for the year of $4,497,840.69 resulting from the addition to that account as it stood at the close of 1923, of the total expenditures made in 1924 for additions and improvements, and the deduction therefrom of depreciation and obsolescence charges for the year 1924. Quick assets decreased $712,743.19, and accounts payable increased $26,630.77.

In the report submitted by Chairman W. L. Clause and President Charles W. Brown it was stated that the demand for plate glass was not as vigorous in 1924 as in 1923, and the market was less favorable. The decrease in demand was primarily due to more conservative buying on the part of the automobile manufacturers. Imports continued high, approximating seventeen million (17,000,000) square feet, and curtailed the sale of domestic glass. New capacity aggregating seventeen million (17,000,000) square feet a year was placed in operation during 1924 by the company and other manufacturers, and a further capacity of twenty million (20,000,000) square feet is now in course of construction. Plans have been approved for plants that will produce an additional ten million (10,000,000) square feet per year (including a second unit to the new plant at Creighton, which the Board has just authorized), which will make the productive capacity of the United States about one hundred and forty million (140,000,000) square feet. This is more than ample to take care of the present consumption, or any increase that is likely to develop during the next few years.

The Creighton plant, to be enlarged as above mentioned, was placed in full operation the latter part of the year, and has given promise during its brief operation of effecting the important economies that were expected.

February Building Activities

Building activity continues to run very close to the rate established in the early part of last year, according to F. W. Dodge Corporation. February building contracts in the 36 Eastern States (which include about seven-eighths of the total construction volume of the country) amounted to $299,260,000. This was very slightly under the figure for February of last year and less than 1 per cent over the figure for January of this year. The combined total for the first two months of this year, $595,653,000, shows a decline of one-half of one per cent from the first two months of last year.

Although the total building volume of the two years has been running so close, there has been a shifting of activity as to localities and as to classes. There has been a decided falling off in New York State and Northern New Jersey; a slight decrease in the Northwest; a slight increase in the Central West; and substantial increases in New England, the Pittsburgh district and the Southeast. Public Works and utilities contracts have increased considerably, taking up the slack in other classes of construction.

February's total of $299,260,000 included: $136,023,200, or 45 per cent of all construction, for residential buildings; $52,865,200, or 18 per cent, for public works and utilities; $38,825,100, or 13 per cent, for commercial buildings; $20,767,200, or 7 per cent, for industrial buildings; and $20,278,000, or 7 per cent, for educational buildings.

February building contracts in New York State and Northern New Jersey dropped to $63,581,300, the lowest monthly total since February two years ago. The decrease from January was 43 per cent; from February of last year, 41 per cent.

Standard Plate Glass Annual Report

Report of Standard Plate Glass Company, Pittsburgh, and subsidiaries for year ended December 31, 1924, shows profit of $923,203 after depreciation, interest and federal taxes. This amount includes $61,691, profits of five companies taken over, from January 1 to dates of acquisition. Deducting this amount, balance of $861,512 is equivalent after preferred dividends to $1.73 a share earned on 200,000 outstanding shares of no par common stock.

Consolidated income account for year ended December 31, 1924, follows:

Operating profit	$1,494,412
Other income	196,695
Total income	$1,691,107
Depreciation	561,664
Interest, etc.	197,147
Federal taxes	9,093
Profit	$923,203
* Other deductions	61,691
Net profits	$861,512
Prior preferred dividends	105,000
Preferred dividends	408,723
Common dividends	285,345
Surplus	$62,444

* Profits of five newly acquired companies from January 1, 1924, to dates of acquisition.

Hazel-Atlas Annual Report

At the annual meeting of the stockholders of the Hazel-Atlas Glass Company held on February 24 at Wheeling, J. C. Brady, chairman of the board of directors, submitted the annual report for the fiscal year ending December 27, 1924, showing net profits of $931,652. During the year $978,901 was spent for maintenance and improvements and $536,773 charged off for depreciation, Federal taxes, etc.

Mr. Brady said:

> "Business generally started off in 1924 under favorable conditions. As the political campaign developed, with its radical proposals and uncertain outcome, favorable conditions changed to general depression.
>
> Your company, like others, was affected by this condition and as a result operations for the year ending December 27, 1924, were only 66 per cent. of capacity, in contrast with 85 per cent. for the year ending December, 1923.
>
> The glass industry continues to be most highly competitive. However, the volume of business so far in 1925 exceeds that of the same period in 1924. Any general improvement in business conditions should be reflected in our volume of sales as the year advances and favorably affect our earnings."

Directors were elected as follows: To serve three years, J. C. Brady, George W. Hannan and J. H. McNash; two years, J. J. Holloway, D. A. Burt, J. D. Biggers and one year, C. R. Hubbard, W. H. Boshart and C. A. Robinson.

United States Glass Company Annual Report

The annual report to stockholders of the United States Glass Company, Pittsburgh, for 1924 showed a net loss of $164,197 after deducting depreciation charges of $141,161, losses of $7,650 and dividends of $141,295. After reserving $128,219 for Federal taxes and contingencies, the surplus for the year was $2,522,288. President Slick stated that sales for the year were about 25 per cent below the minimum quota deemed necessary for successful operation; that there is an urgent necessity for improvements and rehabilitation of the various plants to enable economical and profitable operations; certain improvements have already been made at one plant with gratifying results, and that the company is now

installing equipment in the various plants to eliminate losses.

The following directors were elected for the ensuing year: Marion G. Bryce, M. B. Goff, L. A. Meyran, Ernest Nickel, J. B. Orr, E. E. Slick, H. N. Trimble, C. E. Willock and David Yost.

American Ceramic Society Activities

The American Ceramic Society's summer meeting will be held in Canada, probably early in July. The fall meeting will be held in connection with the Chemical Exposition in New York, and the next annual meeting at Atlanta, Ga., early in February, 1926.

The board of trustees on February 9, 1925, adopted the following budget for 1925-1926:

Journal		$16,000
Reprints		1,000
Salaries:		
Secretary	$5,000	
Asst. secretary	1,800	
Asst. editor	2,000	
Assistant	1,200	
Extra	1,300	
		11,300
Traveling		1,000
Office expense		4,000
Meeting		1,500
Committees		300
Divisions		1,000
Miscellaneous		500
Contingent fund for president		800
Editorial assistance		2,500
		$39,900

Foreign Commerce in Glass Increases in January

There was an increase in both imports and exports of glassware during January, 1925, as compared with the preceding month. The total value of imports increased from $1,155,620 to $1,223,719. The value of sheet glass increased from $109,709 to $202,171. Imports of plate glass increased from $451,089 to $517,725, glass containers from $14,174 to $17,999. However, there was a falling off in the value of cut and decorated glassware imported, amounting to $18,377.

Exports increased from a total of $626,287 in December, 1924, to $645,871 in January, 1925. There was a decline in the exportation of window glass from $11,682 to $6,477 and also of plate glass, the value of which decreased from $41,055 to $24,390. Exports of glass containers remained practically unchanged. There was a sharp rise in the value of electrical glassware exported from $9,161 to $19,120. Chemical glassware rose from $11,803 to $16,503, globe and shades for lighting fixtures showed an increase in value exported of $7,635. For complete figures showing imports and exports of glass see page 92.

Oil and Gas Power Week

A group of prominent engineering and chemical societies together with the National Safety Council and the United States Bureaus of Standards and Mines are co-operating to celebrate "Oil and Gas Power Week" April 20 to 25, 1925. Technical meetings will be held in over thirty cities and the cooperation of seventy-five engineering schools is assured. A list of fifty-nine subjects covering the oil and gas-power field have been prepared and topics for nation-wide discussion will be selected from it. William E. Bullock, assistant secretary of the American Society of Mechanical Engineers, 29 West 39th Street, New York, is corresponding secretary for the event.

Pittsburgh Plate Glass Will Enlarge Creighton Factory

The fact that the Pittsburgh Plate Glass Company has approved plans for the construction of a new manufacturing unit at their Creighton, Pa., plant was confirmed in the report of Chairman W. L. Clause and President Charles W. Brown at the annual meeting held March 10. The new unit will have a capacity of about 10,000,000 square feet annually, the glass to be melted in tanks and made by the new continuous process which was inaugurated when the new process plant at Creighton was put into operation last year. Contracts are reported to have already been let for 5,000 tons of structural steel from McClintic-Marshall Construction Company, and 500 tons of steel of special composition from the Pittsburgh Bridge & Iron Company.

Joint Convention of Lighting Fixture Associations

Arrangements will be completed at an early date, according to R. W. Smith, secretary of the National Association of Lighting Equipment Dealers for a joint convention of that association with the National Council of Lighting Fixture Manufacturers and the Illuminating Glassware Guild. The date and location for the convention have not been definitely fixed, but it will probably be held late in June at either Atlantic City, Chicago or French Lick Springs.

Glass Container Association Annual Meeting

The Glass Container Association will hold its annual meeting at the Marlborough-Blenheim Hotel, Atlantic City, N. J., April 30, May 1 and 2. Thursday afternoon, April 30, will be devoted to a general meeting, a talk by E. W. McCullough of the Department of Commerce and the reading of one or more technical papers. On Friday morning, May 1, the regular business meeting will be held and reports made by various committees, with a banquet in the evening. A golf tournament will be held on Saturday, May 2.

Harbison-Walker Refractories Company Report

The annual statement of the Harbison-Walker Refractories Company, Pittsburgh, Pa., shows net operating profits for the year ending 1924 of $3,496,113, after deducting $675,285 for depreciation and depletion. Dividends to the amount of $1,684,425 were paid and $3,811,688 added to the surplus, making a total surplus at the end of 1924 of $11,526,814.

American Chemical Society Meeting

The sixty-ninth meeting will be held at Baltimore, Md., April 6 to 10. Among the papers on the program of the division of Industrial and Engineering Chemistry for Thursday morning, April 9, is one by Dr. G. W. Morey on "The Corrosion of Glass Surfaces." The paper will be discussed by A. E. Marshall.

Trade Activities

The Western Glass Company, Shirley, Ind., resumed operations early in March after a year's shutdown.

The Porter Mirror Manufacturing Company recently began operations in their new modern factory located at Maywood, Cal.

The Co-Operative Enterprise Glass Company's plant at North Vernon, Ind., was seriously damaged by fire on March 18.

The Mountain State Glass Company, Mannington, W. Va., manufacturers of window glass, have resumed operations giving employment to over 200 men.

The Southern Window Glass Company, Grafton, W. Va., which was reported as about to re-open, will not operate during the spring period.

The Maryland Glass Corporation, Baltimore, Md., are erecting a new 2-story, 30 x 83 ft. factory building of brick and steel construction at a cost of about $50,000.

The Gastonia Glass Company, 419 W. Main street, Gastonia, N. C., has been organized by the consolidation of the Smith Glass Company and the Gastonia Glass Company.

The Interstate Window Glass Company's factory No. 4, located at Weston, W. Va., is now in operation and reports that they are making the best glass they have ever manufactured.

The Allentown Glass & Mirror Works, Allentown, Pa., have completed the installation of new beveling, polishing and mitering machines and are in a position to take care of all inquiries for mirrors, automobile and beveled glass.

The Mathieson Alkali Works, Inc., have removed their general offices from 25 West 43rd street to 250 Park avenue, New York, where larger and better facilities for the efficient handling of the company's expanding business are available.

The Potash Importing Corporation of America, sales agent in the United States for the German Kali Syndicate, will move its offices on or about May 1 to 8-10 Bridge street.

The A. H. Heisey Glass Company, Newark, O., recently put into operation a new furnace which will double the production capacity and increase the number of employes.

The Alliance Window Glass Company, Salem, W. Va., resumed operation on March 19, giving employment to over a hundred men. Owing to conditions in the window glass trade the plant had been closed for many months.

The Lafayette Mirror Company, Inc., manufacturers, importers, and dealers in mirror and plate glass, have moved from 173-175 Grand street, New York City, to 68-76 Rutledge street, Brooklyn, N. Y.

The Rosen & Collins Company, 20 Lake street, Chicago, Ill., has been incorporated with a capital of $25,000 to manufacture and deal in glass products. The incorporators are: H. T. Rosen, W. W. Collins and L. Loewenstein.

The Dayton Art Glass Works, Dayton, O., has been purchased from Paul Winterlich by D. W. Smyers, who plans extensive improvements and expansion of the business. The plant operates decorating, etching and re-silvering departments.

The Western Window Glass Company is negotiating for the plant of the Stockton Glass Works, Stockton, Cal., which has been idle for the past four years. The Western company has been incorporated by the following: Morris Davidson, Everett H. Wolf, G. Lewis Fox, Steven Pierce and George Dare.

The Saginaw Mirror Works, Saginaw, Mich., has been merged with the **Standard Plate Glass Company,** Pittsburgh, Pa. The plant is to be enlarged and will be in charge of F. O. Guider. The Saginaw Company reported sales in 1924 to the amount of $500,000.

The Fredonia Window Glass Company, Fredonia, Kans., began hand-blowing operations on February 24 with three shifts of 16 blowers each. The company expects to operate until the latter part of June when the plant will be closed to install window glass machines.

The Knox Glass Bottle Company, Knox, Pa., through R. R. Underwood, general manager, authorizes the statement that the construction of the furnaces which they propose to install will begin sometime during the coming summer, not immediately as reported in the daily press.

The Laclede-Christy Clay Products Company, St. Louis, Mo., state that so much interest has been manifested in their pamphlet, "Checker Tile in Glass Melting Furnaces," that an additional supply has been prepared and that anyone interested in the subject can obtain copies on request.

The Licking Window Glass Company property at Utica, O., was sold at public auction on March 14, under foreclosure of a mortgage in the sum of $161,907 and 8 per cent interest, given to the Cleveland Trust Company as trustee for the holders of bonds of the company.

The Indiana Glass Company, Dunkirk, Ind., at a recent stockholders' meeting, elected the following officers: Frank W. Merry, president; Charles W. Smalley, vice-president and Charles L. Gaunt, secretary-treasurer. The newly elected directors of the company included the officers and Henry J. Batsch and Rathbun Fuller.

The Corning Glass Works, Corning, N. Y., will close its Wellsboro, Pa., plant within the next month. No assurances have been given by the Corning Company as to when the plant, which has given employment to 400 men and women, will be reopened, but it is asserted that the works will not be dismantled.

The Illinois Window Glass Company's plant and property at Danville, Ill., was sold at a public sale on March 16 to bondholders. The price paid was $250,000 subject to the $30,000 mortgage held by the gold bond owners. Firmin Pacot, trustee, reports that the outlook for re-organization of the company and resumption of operations next fall is favorable.

The Nurre Glass Company, now operating at Chattanooga, Tenn., is building a new plant at Memphis for occupancy and operation about May or June. The Nurre Glass Company is associated with the Nurre Mirror Plate Company, operating plants in Bloomington, Ind.; Burlington, Ia.; St. Louis, Mo., and with the J. M. Nurre Glass Company, Kansas City, Mo. The plant will cost approximately $50,000.

The Excelo Glass Manufacturing Company which was recently organized to take over the plant of the Henryetta Glass Company, Henryetta, Okla., has been in operation about four weeks manufacturing lamp chimneys, lantern globes, gas globes, etc. The officers of the new company are: O. A. Freeburn, president; E. Deacon, vice-president; P. F. Buchhold, 2nd vice-president, and B. D. Gladding, secretary-treasurer.

The Ohio Glass Products Company, Massillon, O., elected the following directors at a stockholders' meeting held on February 3: C. E. Stuart, H. S. Potter, C. E. Swanson, F. F. Taggart, A. T. Ellis, L. F. Graybill, S. M. Baltzly, E. R. Albrecht, C. L. Baatz, E. H. Nelson, Andrew Reese, E. M. Brickell, H. C. Daubenspeck, E. A. Griffiths and W. E. N. Hemperly.

The Irving Cut Glass Company, Inc., of Honesdale, Pa., has purchased the entire equipment, good-will, finished and raw material of the White Mills Decorating Company and removed it to the Irving plant where the former owners, Charles and Alex LaTournous, as well as their former employees, will be engaged. The Irving plant is now making samples and it is stated that they will put on the market one of the best lines of gold decorated, iridescent and combination colored and gold ware.

The Morris Glass Company, Inc., New York, which for the past twenty years has been located at 438 to 448 Canal street, has been forced to acquire a new location because of the property they have been occupying being required for the construction of the new Holland Tubes under the Hudson River, and a few weeks ago purchased a six-story building at the southeast corner of Washington and Laight streets, into which they recently moved. The new premises are well equipped for handling the large business in flat glass, and colored and ornamental glass imports and exports which the company has built up since its establishment 88 years ago.

The Continential Flat Glass Company, Shreveport, La., announce the following changes in their personnel. Irving E. Adams, who has been closely identified with this enterprise for several months, assumed the superintendency of the plant on February 9. Carl D. Smith, the well known fuel engineer, and for several years past connected with the Simplex Engineering Company, Washington, Pa., has joined Mr. Adams in the capacity of mechanical superintendent in charge of machine operation. Another addition to the staff is J. W. Jeffords, a graduate mechanical engineer of Washington University, and for the past two years engaged in fuel combustion work for the Union Electric Light & Power Company, St. Louis, Mo.

Personal Items

J. B. Hayes, who has been connected with the Illinois Glass Company for the past ten years as manager of the traffic and purchasing departments, has been appointed resident manager of the company's plant at Gas City, Ind.

Professor Alexander Silverman, head of the Chemical Department of the University of Pittsburgh, was elected chairman of the Glass Division of the American Ceramic Society at the recent annual convention. **Herbert Insley,** of the Bureau of Standards was made vice-chairman and **A. N. Finn,** also of the Bureau, was elected secretary.

J. Vigne, of the San Marina Glass Company, Sao Paulo, Brazil, whose visit to this country was announced in the March issue, has arrived and is making his headquarters with G. Muntz, president, Tropenas Corporation, Cunard Building, 25 Broadway, New York, until about the middle of April. Mr. Vigne is interested in new and improved equipment and apparatus of all kinds for use in manufacturing bottles and window glass; also patents, processes and supplies.

Recent Deaths

Edmund B. Ball

Edmund B. Ball, vice-president and general manager of Ball Brothers Company, and one of the most prominent citizens of Muncie, Ind., died at his home in that city on March 8 as a result of a stroke of paralysis which he suffered about three months earlier.

Mr. Ball was born in Greensburg, O., in 1855 and when he grew up, after various activities he and his brother Frank started

in the business of manufacturing oil cans in connection with which the manufacture of glass was later added. In 1877 when natural gas was discovered in Indiana, Lucius, William and George Ball joined them in establishing a glass factory at Muncie.

Ball Brothers Company became the largest manufacturers of fruit jars in the world and also operate a paper mill, corrugated fibre plant, zinc mill, and another glass factory at Wichita Falls, Tex.

Mr. Ball was also interested in numerous other industrial and commercial enterprises and was very active in local community enterprises and philanthropic work, frequently sacrificing his own interests to devote his time to public welfare. He made large gifts to charitable and other public welfare organizations. The immediate survivors are his wife, Mrs. Bertha Crosley Ball; one son, Edmund Ferdinand; two daughters, Adelia and Janice; three brothers, Frank C., George A., and Dr. Lucius L. Ball, and one sister, Mrs. Frances B. Mauck.

William L. Curry

William L. Curry, president of the Pittsburgh Lamp, Brass & Glass Company, Pittsburgh, Pa., died on March 22 at the age of fifty. Mr. Curry was born in Pittsburgh and had always lived there and been active in business affairs. Besides his interest in the Pittsburgh Lamp, Brass & Glass Company he was chairman of the board of the National Fireproofing Company, treasurer of the Ft. Pitt Steel Company, and director in the First National Bank of Pittsburgh. He was also the organizer of the McKeesport Tin Plate Company.

E. J. S. Van Houten

E. J. S. Van Houten, president of the Williamsburgh Flint Glass Company, Brooklyn, N. Y., and for many years connected with the glass industry, died at his home in Nyack, N. Y., on March 6. He is survived by his wife, a son, E. B. Van Houten, secretary of the company, and a daughter.

J. J. Paquet

J. J. Paquet, president of the Paquet Glass Company, Shinnston, W. Va., died at his home on March 1. Mr. Paquet was sixty-three years of age. He is survived by his wife, son and two daughters.

Coming Meetings

AMERICAN CHEMICAL SOCIETY, sixty-ninth meeting at Emerson Hotel, Southern Hotel and Engineers' Club, Baltimore, Md., and divisional and sectional meetings at Johns Hopkins University, April 6 to 10.

NATIONAL LIME ASSOCIATION will hold its seventh annual meeting in conjunction with the twenty-third annual meeting of the Lime Manufacturers at Briarcliff Lodge, Briarcliff, near New York, May 26-29, 1925.

THE GLASS CONTAINER ASSOCIATION will hold its annual meeting at the Marlborough-Blenheim Hotel, Atlantic City, N. J., April 30, May 1 and 2, 1925.

AMERICAN CERAMIC SOCIETY will hold its summer meeting in Canada early in July, 1925.

FIRST CHEMICAL EQUIPMENT EXPOSITION will be held at Providence, R. I., June 22 to 27, 1925, under the auspices of the Association of Chemical Equipment Manufacturers, 1328 Broadway, New York.

NATIONAL ORNAMENTAL GLASS MANUFACTURERS' ASSOCIATION will hold its annual convention in Pittsburgh, June 24 to 26, 1925.

AMERICAN FLINT GLASS WORKERS' UNION annual convention will be held the first week of July, 1925, in Toledo, O. Following this meeting the annual wage conferences with the manufacturers' committees will be held at Atlantic City.

Inquiries Received

For Further Information Address THE GLASS INDUSTRY

255. I am interested in the manufacture of a cheap grade of 1 ounce bottles and 2 ounce ink bottles. I have been a large importer of this kind of ware from the United States but the Mexican government having recently raised the duty price on these bottles their importation is now impossible. Please advise me fully as to equipment and costs to manufacture the above mentioned articles on a small scale and also the cheapest kind of fuel with which a glass of this nature can be produced. (Feb. 24).

256. We would like the names of manufacturers of equipment for engraving glass by means of the sand process (Mar. 6).

257. Can you give us the names of manufacturers of glass bottles for mineral water? (Mar. 4).

258. We are interested in procuring novelties such as glass trays for smoking stands, bridge lamp decorations, etc., and would like to get in touch with manufacturers of such articles. (Mar. 11).

259. Can you give us the names of manufacturers or importers of ruby colored reflector lenses for use in traffic signals. (Mar. 9).

260. We are in the market for plate glass for automobiles, windshields, mirrors, etc. (Mar. 10).

261. We expect shortly to put in a continuous tank and would like to receive catalogs and also find source of supply for pipes, chemicals and shipping cartons. (Mar. 21.)

262. We will close factory late in June to install window glass machines (Mar. 23.)

Stock Quotations

Reported by Moore, Leonard & Lynch, Union Trust Bldg., Pittsburgh, Pa.

PITTSBURGH STOCK EXCHANGE, MARCH 23, 1925

	Bid	Ask	Last
American Window Glass Machine, com.	90	92	92
American Window Glass Machine, pfd.	95½	96	98
American Window Glass, preferred	112	113	113
Pittsburgh Plate Glass	275	280	280
U. S. Glass	16	17½	18
Standard Plate Glass, common	11¼	12	11½
Standard Plate Glass, preferred:			
Cumulative	73	74	74
Prior	93	95	94

Glass stocks on the Pittsburgh Stock Exchange ruled moderately lower on decreased activity in the past month. Building activity continues to run close to the rate established in the early part of last year. February building contracts in the United States were slightly under the figure for February of last year and less than 1% over the figure for January of this year. The combined total for the first two months of this year of $595,653,000 shows a decline of one half of 1% over the first two months of last year. Fifty per cent of all contracts in last month's record was for residential buildings. The automobile trade outlook is steadily improving. On the basis of orders on hand, it is probable that the Spring 1925 passenger car trade will exceed that for 1924. There has been no general move toward wage reduction, because a marked improvement in the efficiency of labor is noted. Since last June, production of all commodities in the United States increased 35%; employment gained but 6%.

WHEELING STOCK EXCHANGE, MARCH 23, 1925.

Hazel Atlas	32	33	33
Imperial	75	88	88
Fostoria	145	..	140
Central	93	95	105

The Wheeling market has lately displayed considerable activity in the expectation that operations will be increased for the next 90 days.

TOLEDO STOCK EXCHANGE, MARCH 23, 1925.

Owens Bottle Machine, common	43⅞	44⅛	44
Libbey-Owens Sheet Glass, common	110	114	112
Libbey-Owens Sheet Glass, preferred ..	111	113	112

READERS' WANTS

Practical Glass Chemist

With seven years' experience desires position as plant chemist, or in consulting capacity. Fully qualified to take entire charge of glass manufacture and operation of furnaces. Address, Practical Chemist, care THE GLASS INDUSTRY, 50 Church St., New York.

Chemist

Chemist now employed desires change. Ten years' experience, including temperature and batch control. Married, Salary two hundred dollars, Interview. Address, Glass Chemist, care THE GLASS INDUSTRY, 50 Church St., New York.

Manager of large European Manufacturer

WITH

practical experience and thorough knowledge of glass business, especially chemical glassware and thermos bottles, and recognized organizer is open for similar position in the United States. Address **A. 5. 70 Ala, Anziegen A. G. in Magdeburg, Germany.**

Current Prices of Glass-Making Materials

Quotations furnished by various producers, manufacturers and dealers.

March 24, 1925

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	.05	.05½
Aluminum oxide (Al_2O_3)	lb.	..	..
Antimony oxide (Sb_2O_3)	lb.	..	.17
Antimony sulphide (Sb_2S_3)	lb.	..	.08½
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.05¼	.06
Barium carbonate ($BaCO_3$)			
Precipitated	ton	..	..
Natural, powd.	ton	42.00-50.00	45.00-55.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05½
Bone ash	lb.	.06	.06½
Borax ($Na_2B_4O_7 10H_2O$)	lb.	.04¾	.05
Borax, fused ($Na_2B_4O_7$) any mesh	lb.	..	..
Boric acid (H_3BO_3)	lb.	..	.08½
Boric acid, refined	lb.	.09	.09½
Cadmium Sulphide (CdS)—			
Red	lb.	..	1.35
Orange	lb.	1.20	1.30
Yellow	lb.	..	1.75
Chrome Oxide (Cr_2O_3)	lb.	..	.34-.35½
Cobalt Oxide (Co_2O_3)—			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide—			
Red (Cu_2O)	lb.	..	.23
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	..
Cryolite (Na_3AlF_6)	lb.	..	.09⅛
Feldspar—			
100 mesh	ton	12.00-14.00	16.00
80 mesh	ton	12.00	..
40 mesh	ton	12.00	..
Ferric oxide (Fe_2O_3)	ton	..	.02¼
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	40.00	..
Powdered white, 90%	ton	38.00	..
Hydrochloric acid (20°) (Carboy $5)	lb.	..	.01
Hydrofluoric acid (HF) 60% (in lead carboys)	lb.	..	.13-.13½
52% and 48%	lb.	..	.10-.11½
Kaolin (f.o.b. mine)	ton	10.00	..
English, ex. vessel	ton	16.50-23.50	..
Lead Oxide (Pb_3O_4) (red lead)	lb.	.13	.13¼
Litharge (PbO)	lb.	.12½	.12¾
Lime—			
Hydrated ($Ca(OH)_2$) (in 50 lb. paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls. per bbl.		2.15	2.30
Magnesium carbonate ($MgCO_3$)	lb.	..	.08
Manganese 85% (MnO_2)	lb.	.03½	.03¾
Nickel oxide (Ni_2O_3), black, for nickel content	lb.	..	.35
Nickel monoxide (NiO), green, for nickel content	lb.	..	.35
Nitric acid (38°) (Carboy $5)	lb.	..	.04¾-.05
Potassium carbonate—			
Calcined (K_2CO_3) 96%	lb.	.06½	.07
Hydrated 85%	lb.	.05¾	.06
Potassium nitrate (KNO_3) (gran.)	lb.	.06	.06¼
Potassium permanganate ($KMnO_4$)	lb.	.15	.16
Powdered blue	lb.	..	.24
Rochelle salts	lb.	..	.20
Salt cake, glassmakers (Na_2SO_4), f.o.b. works	ton	22.00	..
Selenium (Se) black, powd.	lb.	..	2.15-2.20
Red, powd	lb.	..	1.95
Silver nitrate ($AgNO_3$) 100 oz., per oz.		..	.46-.48
Soda ash (Na_2CO_3) dense, 58%— f.o.b. works.		..	..
Bulk, spot....Flat	100 lb.	1.40	..
Bulk, on contract....Flat	100 lb.	1.35	..
In 400 lb. bbls., on contract.	100 lb.	1.69	2.40
In 400 lb. bags, on contract.	100 lb.	1.45	..
Spot orders .05 per 100 lbs. higher.			
Sodium nitrate ($NaNO_3$),			
Refined (gran.) in bbls.	lb.	.03½	.03¾
95 per cent		.02⅜	.02¾
Sodium selenite (Na_2SeO_3)	lb.	..	2.35
Sodium fluosilicate (Na_2SiF_6)	lb.	..	.04¼
Sodium uranate (Na_2UO_4)	lb.	..	1.25
Sulphur (S)—			
Flowers, 155 lb. bbl. Per	100 lb.	3.35	3.65-3.90
Flowers, in bags....Per	100 lb.	3.00	3.30-3.55
Flour, heavy, in bbls..Per	100 lb.	2.40	2.85-3.05
Tin oxide (SnO_2) in bbls	lb.	..	.61
Uranium oxide (UO_3), 100 lb. lots	lb.	..	1.25
Zinc oxide (ZnO)	lb.	.08	.08¼

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to February 24, 1925

Glass and glass products (total)	January 1924 Quantity	January 1924 Value	January 1925 Quantity	January 1925 Value	Seven Months Ending January 1924 Quantity	Seven Months Ending January 1924 Value	Seven Months Ending January 1925 Quantity	Seven Months Ending January 1925 Value
	.....	$740,402	.....	$645,871	.....	$6,138,572	.....	$4,917,025
Plate and window glass—								
Window glass, common, box 50 sq. ft.	8,781	28,764	873	6,477	35,066	152,086	20,913	100,896
Plate glass, unsilvered, sq. ft.	198,761	64,346	103,196	24,390	912,993	385,934	890,477	247,685
Other window and plate glass, n.e.s. lbs.	266,719	22,378	96,750	12,229	1,475,014	161,974	1,176,086	118,784
Glass containers (bottles, vials and jars) lbs.	3,646,039	184,372	4,811,950	213,427	39,475,045	1,903,101	36,686,154	1,655,086
Table glassware, plain lbs.	1,261,162	150,937	1,237,206	137,361	11,809,296	1,348,042	9,894,543	1,033,374
Table and other glassware, cut or engraved lbs.	18,834	9,823	15,971	6,005	350,166	114,520	366,300	107,383
Glassware for lighting—								
Lamp chimneys and lantern globes lbs.	169,651	33,560	156,024	24,893	1,200,512	226,480	1,118,584	193,270
Globe and shades for lighting fixtures lbs.	154,728	38,677	109,022	38,369	1,099,648	293,858	830,526	237,624
Lamps and other illuminating devices, chiefly of glass lbs.	118,752	35,291	73,476	20,968	928,953	222,955	537,217	158,104
Chemical glassware lbs.	14,793	13,050	21,351	16,503	161,043	111,661	158,650	124,069
Electrical glassware, except for lighting lbs.	167,377	17,154	144,534	19,120	1,435,424	106,137	1,008,772	121,296
Other glassware, n.e.s. lbs.	1,165,735	142,050	626,809	126,129	6,817,001	1,111,824	3,757,178	819,454

IMPORTS

Corrected to February 24, 1925

Glass (total)		$1,491,683	.....	$1,223,719	.....	$15,643,403	.....	$10,025,002
Cylinder, crown and sheet—								
Unpolished, lbs. dut.	2,217,731	116,304	3,724,835	202,171	22,755,834	1,105,530	18,432,606	1,015,834
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	47,435	.....	41,289	.....	462,009	.....	277,230
Plate glass—								
Unsilvered, sq. ft. dut.	1,506,663	952,593	1,048,997	517,725	16,336,897	10,490,748	7,866,604	4,104,607
Fluted, rolled, etc., or silvered, or containing wire netting, sq. ft. dut.	249,882	38,297	153,875	28,365	1,353,681	215,187	1,208,330	194,954
Containers—bottles, vials, etc. dut.	.....	20,659	.....	17,999	.....	85,070	.....	99,212
Table and kitchen utensils, lbs. dut.	64,803	9,160	52,120	5,393	524,455	115,170	433,116	106,190
Glassware, cut or decorated, lbs. dut.	243,192	116,786	242,488	158,748	2,384,510	1,030,562	2,642,111	1,340,584
Blown glassware, n. e. s., lbs. dut.	.....	.....	.....	.....	13,402,894	1881,319	.....	.....
Bottles, ornaments, etc., lbs. dut.	153,984	60,668	161,465	55,629	2153,984	260,668	4,801,242	1,311,487
Bulbs or electric lamps, number dut.	475,795	4,981	952,212	8,424	2425,795	24,981	9,645,515	115,356
Chimneys, globes, shades, etc., lbs. dut.	282,634	37,456	460,294	97,502	2282,634	237,456	2,876,873	659,976
Articles and utensils for chemical, scientific, and experimental purposes, lbs. dut.	56,238	19,504	55,609	23,617	256,238	219,504	552,925	198,269
Other glassware dut.	.....	67,840	.....	66,857	.....	1,135,259	.....	601,303